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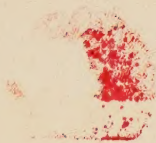
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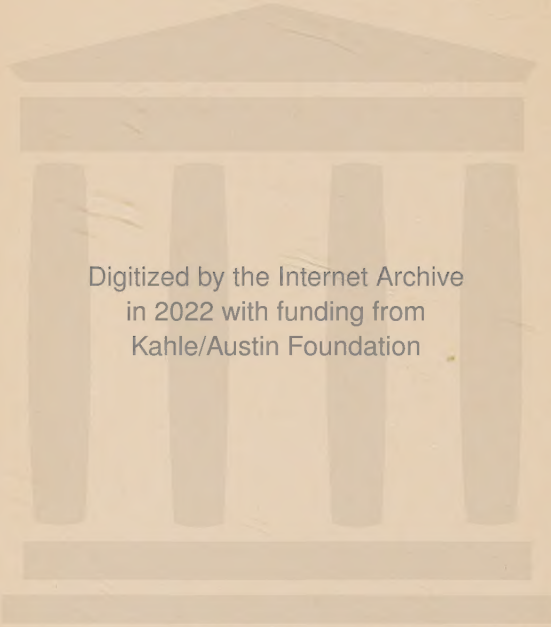


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INSECTS AND INSECTICIDES



Y. Dalmata, *Z.*

PLATE I. TRANSFORMATIONS OF THE CELERY CATERPILLAR

INSECTS AND INSECTICIDES

A PRACTICAL MANUAL

CONCERNING

Noxious Insects and the Methods of Preventing Their Injuries

BY

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and the Mechanic Arts

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**TEN NEW ENGLAND BLOSSOMS AND THEIR
INSECT VISITORS**

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PREFACE

This volume has been prepared for the purpose of furnishing the farmer, the fruit grower, the floriculturist, and the housekeeper with a concise account of the more important injurious insects with which they have to contend, together with a summary of the latest knowledge concerning the best methods of preventing or counteracting the injuries of these pests. In its preparation free use has been made of the information scattered through the literature of economic entomology; and, as a rule, it has been found impracticable to give to each author credit for first working out the life histories of the various species. In one way or another the contributions of nearly every American economic entomologist have been drawn upon; but especial mention should be made of the help obtained from the publications of Dr. C. V. Riley, recently United States entomologist, whose remarkable investigations during the last quarter of a century have placed him foremost among the world's economic entomologists. Mention should also be made of the aid derived from the writings of Messrs. Bruner, Cook, Comstock, Fernald, Fletcher, Forbes, Garman, Gillette, Harvey, Howard, Lintner, Osborn, Packard, Saunders, Slingerland, and many others.

The illustrations of this volume have also been gleaned from various sources. I am under obligations to the authorities of the Department of Agriculture and various experiment stations, particularly those of Illinois, Cornell University, Colorado, Kentucky, Nebraska, New Jersey and Ohio,—for the privilege of getting duplicate electrotypes. The authors to whom each of

those figures that did not first appear in my own publications should be credited, are indicated in the following list :

After Riley:—Plates III, IV, VI, XII, and figures 1-4, 8, 15, 23-27, 36-45, 59, 61, 63, 67, 69, 70, 72, 74-76, 78*a*, 79, 81-95, 97-103, 105, 119-121, 123, 124, 127-129, 133-139, 141, 144, 146-149, 150, 155, 157-162, 164-166, 168, 170, 172-176 ; after Lugger, fig. 5 ; after Osborn, figs. 169-171 ; after Garman, figs. 68, 71, 104 ; after Bruner, figs. 13, 14, 62, 80, 145 ; after Miss Ormerod, fig. 167 ; after Howard, figs. 46-50 ; after Comstock, fig. 141 ; after Lake, plate V, fig. 28 ; after Goff, fig. 132 ; after Smith, plate XV, figs. 9, 10, 122 ; after Slingerland, plates VII, X, figs. 30-34, 52-57, 60, 77, 78, 130, 131 ; after Marlatt, fig. 29 ; after Saunders, figs. 51, 116 ; after Packard, figs. 7, 22 ; after Lintner, figs. 16, 58 ; after Popenoe, fig. 108 ; after Gillette, plate VIII, fig. 66 ; after Bailey, fig. 19 ; after Galloway, fig. 18 ; after Forbes, figs. 64, 65, 143, 152-154 ; from *Insect Life*, figs. 12, 73 ; after Taschenberg, plate II, figs. 109-112.

All the figures are natural size unless otherwise stated, and wherever a straight line occurs beside a magnified drawing, it represents the length of the specimen figured.

I have attempted to make the discussions of life histories and remedies as plain and simple as possible, omitting, so far as practicable, all technical terms, and have included only such details as are necessary to a practical understanding of the subjects treated of. In the present second edition the book has been thoroughly revised to date, and the latest available information incorporated.

C. M. W.

New Hampshire College of Agriculture and Mechanic Arts.

DURHAM, NEW HAMPSHIRE, April, 1895.

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INSECTS AND INSECTICIDES

INTRODUCTION

None of the changes modern civilization has made upon the earth is more evident to the American farmer than that of the increased difficulty of saving his crops from the ravages of noxious insects and parasitic fungi. Many of us have heard from our fathers and grandfathers of the apples which once grew in abundance in yards and along highways, strangers alike to the codling moth, maggot or scab; the luscious peaches free from worms and rot; the plums unmarked by the curculio, and the pears that had yet to learn the secret of becoming dwarfed, gnarly and cracked; of the grapes that knew not how to rot and the potatoes whose leaves had neither been blighted nor bitten by the Colorado beetle. Now all is changed: every crop has foes that often gather the lion's share of the harvest. The enemies have come from the north and the south, the east and the west, from Europe and the islands of the sea, and in our own midst they have flocked from the forest to the field, deserting a wild plant for its cultivated congener or changing their habits to conform to a new environment.

This increase of noxious insects, however, is the natural result of the changed conditions of things. Among the principal factors tending toward it may be

mentioned (1) the massing of crops in limited areas; (2) the facilities for transporting insects long distances by vessels and railways carrying agricultural products; (3) the abandoned farms and orchards that serve as breeding grounds; and (4) the destruction of forests and the cultivation of prairies.

Considering each of these factors briefly, we find that the tendency of the first—that of the massing of crops in limited areas—toward increasing our insect pests rests upon the biological law that the increase of any animal is limited by its food supply. Under the natural conditions existing on this continent before the advent of the white man, those insects which fed on wild plants had as a rule only a limited food supply. The apple maggot or railroad worm for example is supposed to have bred originally in the wild haws of the woods. The parent fly had then usually to find here and there an isolated tree bearing the fruit in which it deposited its eggs. Its chances of being caught by a bird or entrapped in a spider's web while on this search were very good, so that the scarcity of the food supply not only directly limited the number of individuals that could be produced, but by being scattered it increased the chances of the adult insects falling a prey to enemies. But in a modern apple orchard all this is changed: the food supply is almost unlimited, and is so massed together that the insect runs little risk in passing from fruit to fruit or from tree to tree. Hence it can multiply indefinitely unless there is some means of checking it. The same line of reasoning applies to a large proportion of our injurious insects.

We are indebted to our commerce on sea and land for many of the most noxious insects. Brought to our shores from Europe, Asia or Australia by ships, many of these pests have found a land which for them was flowing with milk and honey, and in which their hereditary

enemies had not yet gained a foothold. Consequently they have multiplied without let or hindrance; and by natural and artificial means—notably the railroad trains—they have rapidly overrun the country of their adoption.

The abandoned or neglected fields and orchards all over the United States have proven a prolific breeding ground for many insect pests. Too often the efforts of painstaking farmers have been rendered unavailing by the proximity of such sources of infection. An orchard that has outlived its usefulness had better be converted into firewood than left to die uncared for.

The destruction of forests has compelled certain insects to resort to cultivated crops for subsistence; and in some cases a decided change in feeding habits has resulted. So also the bringing of the prairies into cultivation has caused many insects which originally fed on wild grasses to resort to pastures and meadow lands.

The operation of these various causes, together with the enormous powers of multiplication possessed by the insects themselves, have led to a constantly increasing injury to cultivated crops, until to-day these tiny foes exact a tribute of ten per cent. of the crop products of American agriculture. "They form an omnipresent host of taxgatherers, taking possession of the farmer's crops and enforcing their onerous demands without process of law, unless preventive measures are vigorously prosecuted. They are no respecters of persons: like the rain they fall upon the fields of both the just and the unjust.

"The authorities best able to judge have estimated the annual loss in the United States due to these little pests at nearly half a billion dollars. Noxious insects, according to Dr. C. V. Riley, recently the distinguished entomologist of our National Department of Agriculture, occasion losses in the United States which are 'in the aggregate enormous, and have been variously estimated at from \$300,000,000 to \$400,000,000 annually.' In

single States and single seasons the damage is often frightful in extent. During some of the great chinch-bug epidemics the loss in Illinois occasioned by this one insect has amounted to over \$73,000,000 a year; and in seasons not marked by an outbreak of such a great crop pest the injury is much more severe than is ordinarily supposed. The official entomologist of the State just named, Professor S. A. Forbes,—after years of careful field observation and statistical study,—has recently expressed his belief that ‘the insects of the State of Illinois derive as large a profit from the agriculture of this great agricultural State as do the farmers themselves.’ ”*

Fortunately, however, there is an extended silver lining to this dark cloud of insect injury. If these creatures have increased on every hand, our knowledge of methods of controlling them has also augmented with the passing years. Many of the remedies proposed ten or twenty years ago seem now foolish and impracticable. Within the last decade especially the progress has been phenomenal. It has been shown that many insects can be checkmated by a proper crop rotation; that the natural enemies of others can be used to destroy them; and that others are easily killed by improved insecticides. But the most important advance has been the introduction of the spraying machine, an apparatus by means of which insect-killing substances may be easily and rapidly distributed over the surfaces of trees, shrubs, vines and herbaceous plants. Its introduction into American horticulture marks an advance almost as important as was marked by the advent of the improved cultivators into our agriculture. Before the latter were introduced the weeds that infest the soil were fought by the hand hoe, but now a single team does the work of many men. In

*C. M. Weed, Popular Science Monthly, March, 1893.

the same way, until recently, various laborious and partially effective methods were used in fighting noxious insects and destructive fungi; but now many foes of both these classes are fought on a large scale by the force pump and spray nozzle, and every season adds others to the list of those against which this method may be successfully used. With a large class of farmers and fruit growers, spraying has become a recognized part of the season's operations, and therein lies the chief promise of the method. When the belief becomes general that it is as important to save a crop from destruction by its foes as it is to produce it; that fighting noxious worms must take its place as a farm process by the side of that of fighting noxious weeds; that the parasitic plants which absorb the vitality of leaf and fruit are as dangerous to the crop as the plants which dispute with it the possession of the soil, and when along with this recognition there is placed before the farming community a cheap and wholesale method of preventing the injuries of these organisms,—then the vast annual loss now suffered because of insects and fungi will be very greatly lessened. The pages which follow are devoted to a consideration of the more important of the first named of these enemies—the noxious insects—and to the methods of preventing their injuries.

INSECT TRANSFORMATIONS

Insects are distinguished from related animals by having three pairs of feet, fitted for locomotion, attached to a body divided into three principal parts—head, thorax and abdomen. A majority of them are also characterized by undergoing during their development a series of well-marked changes, or transformations. Such insects exist in four distinct stages, namely: (1) the egg; (2) the larva or caterpillar; (3) the pupa or chrysalis; and (4) the adult or imago. As an example

of these changes we may take the celery caterpillar, the transformations of which are illustrated in Plate I. The adult butterfly, a handsome, black creature, with yellow and blue markings on its wings (Plate I, *e*, *f*), deposits an egg on the underside of the celery leaf. This egg (*a*) is a small, light yellow object, nearly spherical though slightly flattened where it is attached to the leaf. A week or so after it has been laid there hatches from it a small caterpillar or "worm," less than one-tenth of an inch long, black, with two transverse white bands—one across the middle of the body and the other at the posterior extremity—and having the back roughened with minute, black, projecting points. This little caterpillar feeds upon the celery leaf, and within a few days so increases in size that it becomes necessary to shed its skin, or molt. For this purpose the skin splits along the back and the caterpillar crawls out, clothed in a new skin that had been formed beneath the old one. The color markings are somewhat different on this new covering. The caterpillar continues feeding and growing for several weeks, casting its skin at occasional intervals, and changing considerably in color and markings. When full grown it is of the form and size indicated at *b* on the plate, the general color being pale green, with a series of transverse bands of black and yellow markings. When irritated it thrusts out, from a slit just back of the head, a pair of peculiar yellow Y-shaped organs, that emit a disagreeable odor. These organs on the caterpillar are represented at *b*, and at *c* is shown a front view of the head, with them extended. They doubtless serve as a protection from various enemies.

The full-grown caterpillar becomes restless, and leaving the plant, seeks some sheltered situation in which to pupate. "It first spins," says Dr. Harris, "a little web or tuft of silk against the surface whereon it is resting, and entangles the hooks of its hindmost feet in it,

so as to fix them securely to the spot ; it then proceeds to make a loop, or girth, of many silken threads, bent into the form of the letter U, the ends of which are fastened to the surface on which it rests on each side of the middle of its body ; and under this, when finished, it passes its head and gradually works the loop over its back, so as to support the body and prevent it from falling downwards. Within twenty-four hours after it has taken its station, the caterpillar casts off its caterpillar skin, and becomes a chrysalis, or pupa (Plate I, *d*) of a pale green, ocher-yellow, or ash-gray color, with two short ear-like projections above the head, just below which, on the back, is a little prominence like a pug nose. The chrysalis hangs in the same way as the caterpillar, and remains in this state from nine to fifteen days, according to the



FIG. 1. CHINCH BUG.
Magnified.

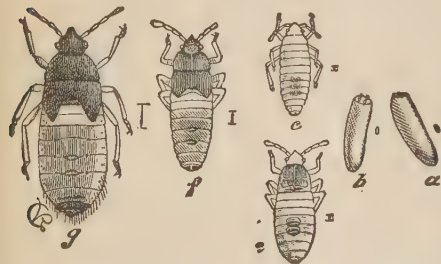


FIG. 2. CHINCH BUG. *a*, *b*, eggs; *c*, *e*, *f*, *g*, young bugs, or nymphs. Magnified.

temperature. When this period is terminated, the skin of the chrysalis bursts open, and the butterfly issues from it, clings to the empty shell till its cramped and drooping wings have extended to their full dimensions,

and have become dried, upon which it flies away in pursuit of companions and food." Besides celery this caterpillar feeds upon parsley, carrots, and related plants.

The butterfly is known to entomologists as *Papilio asterias*.

Insects which undergo such a marked series of changes as those above described are said to have *complete transformations* to distinguish them from those which do not undergo so marked a series of changes—those with *incomplete transformations*. In one stage of existence—that of the chrysalis or pupa—insects of the first class take no food and are unable to move about. With these, also, the young or larva differs greatly in form and appearance from the adult. Thus, caterpillars are very unlike the butterflies and moths into which they develop, and larval honey bees differ greatly from the adults; but with the insects of the second class this marked difference does not exist. The chinch bug furnishes a good illustration of these transformations. The adult bug (Fig. 1) deposits eggs (Fig. 2, *a*, *b*) about the roots of grass and grain. From these hatch young bugs (*c*) that do not differ in general form from the adults. They suck the sap from various plants of the grass family, gradually increasing in size, and molting at intervals. In a few weeks they become nearly full grown, but instead of changing to a quiet chrysalis state, they simply molt again and continue feeding as before. In these early stages, which correspond to the larva and chrysalis, they are called *nymphs*. The older nymphs (*g*) are nearly as large as the full-grown bugs, differing mainly in the absence of wings. In about a week they again molt and come forth as adult bugs. Grasshoppers, crickets, and all true bugs, undergo these incomplete transformations.

BITING AND SUCKING INSECTS

Insects take their food in two ways: some insects bite, others suck. The former, of which the Colorado potato beetle is an example, are provided with jaws by

which they can gnaw the surface of the food plant. The latter have, instead, a pointed, tube-like beak which they can insert into the tissues of their host plant, and suck out the sap.

On account of this difference in feeding habits some insects can be destroyed by coating their food plants with poison—the Colorado potato beetle for example—while others, like the plant lice or chinch bug, must be treated with some insecticide that kills by contact.

NATURAL ENEMIES OF INJURIOUS INSECTS

Injurious insects have many natural enemies to contend with. Among the larger animals they are preyed upon by the “fowls of the air and the fish of the sea;” frogs lick them up with their viscid tongues, and toads are continually sending them in search of the mystic jewel within their bodies, while snakes, lizards, moles, skunks, and a host of other animals are their constant enemies. But more destructive than any or all of these are the foes of their own class—the predaceous and parasitic insects.

Predaceous insects are those which attack other insects from the outside, devouring them bodily, or sucking out their lifeblood. The handsome little lady beetles, the two-winged robber flies, or the four-winged dragon flies furnish good examples of this class. So, also, do the black ground beetles, found everywhere under sticks and stones. Some of the largest of these are called caterpillar hunters, because they feed upon cankerworms, army worms, cutworms, and various other insect pests. One of these ground beetles is shown



FIG. 3. GROUND BEETLE.
a, larva; b, beetle.

at Fig. 3, the larva being represented at the left, and the beetle at the right. Other predaceous insects live in ponds, lakes and rivers, devouring mosquitoes and related creatures, while still others burrow through the earth and devour the insects found therein.

Parasitic insects differ from their predaceous cousins in that they generally develop within the bodies of their victims and thus destroy them. These, also, are exceedingly numerous, both in individuals and species. A good illustration of the habits of this class is found in the small, four-winged, black fly (shown natural size and magnified at the right in Fig. 4), that destroys the com-



FIG. 4. CATERPILLAR WITH COCOONS OF PARASITE. Adult parasite at right; latter magnified.

mon grape caterpillar, an insect closely related to the familiar tomato worm or tobacco worm. This fly deposits a number of eggs beneath the skin of the caterpillar, and these eggs soon hatch into minute worms or maggots that absorb the body juices of the worm and develop at its expense. After a few weeks these maggots become full grown, and burrow their way out through the skin of their hapless and helpless host. They then spin their white silken cocoons (Fig. 4) upon its back. Within these cocoons they change to the pupal or chrysalis state. About two weeks later they again change, and the legless little maggots become transformed into neat and pretty black flies, with four wings and six legs, like the one which a few weeks before deposited in the caterpillar the eggs from which they developed.

The borers that live in the stems of plants are generally attacked by parasites that attach themselves to the skin on the outside, sucking the juices through the openings they make. Such are called external parasites

to distinguish them from the internal parasites just considered.

But these parasites are not always so successful as this, for they frequently furnish a partial illustration of the truth of Dean Swift's oft-quoted couplet:

The little fleas that do us tease
Have other fleas that bite 'em,
And these in turn have other fleas,
And so it goes *ad infinitum*.

These parasites are frequently subject to the attack of a still smaller parasite which destroys them as they destroyed their host. In such cases the first-mentioned species is called the primary parasite, and the second a secondary parasite. There are also foes of another kind from which injurious insects often suffer. These are the germs of contagious diseases, of a bacterial or fungous nature. The imported cabbage worm, for example, is frequently attacked by a bacterial disease—a sort of insect cholera—that destroys it in great numbers. Similar diseases affect the army worm, the various cutworms, and many other insects. Diseases of a some-



FIG. 5. CHINCH BUGS AFFECTED BY FUNGUS.

what different nature, due to certain fungi other than bacteria, also attack many insects. For instance, the chinch bug is frequently destroyed in great numbers by a fungus that develops on the surface of the bug as a dense, white covering. This disease is illustrated at Fig. 5: a number of dead bugs are shown on a wheat

stalk on the left, while a single bug, much magnified, covered with the fungus, is represented at the right.

THE ORDERS OF INSECTS

It is frequently supposed that almost any sort of bugs, worms or spiders that fly or crawl about are insects, but correctly speaking a large proportion of these creatures are not insects at all. For example a spider is not an insect. Neither are the "thousand-legged worms" so often found under boards. In both these cases the creatures have too many legs to belong to the insect class. Spiders have eight legs, and the "thousand legs" a great many more, while as already stated true insects possess but six. Thus by looking at Fig. 6 which represents a harvest spider or "daddy longlegs" the reader will see that there are four legs on each side, making eight in



FIG. 6. HARVEST SPIDER all, while in Fig. 7 which represents a centipede there are many more. But each of the figures of insects shows only three pairs of legs. By counting the number of legs one can generally very easily tell whether one of these animals is an insect or some related creature.

Insects proper are divided into a number of orders, the more important of which are briefly described in the following paragraphs.

The lowest order of the *Hexapoda*—the class of true insects—is the *Thysanura*: it includes the peculiar minute insects commonly known as springtails, bristle-tails and fish moths. These little creatures are wingless and undergo no transformations—never getting beyond

the larval stage; some species have an aggregation of simple eyes on the head, but very few have compound eyes; the principal mouth parts are set back in the head. They inhabit a great variety of situations, being found abundantly under loose bark and boards lying on the ground. Some species, like the fish moth, live in houses or other dry places. "Many of them have a curious spring-like appendage attached to the tail, which is bent under the body, and by means of which the insects are enabled to make leaps that are enormous compared with their small size. Others have long jointed filaments at the end



FIG. 7. CENTIPEDE.

of the body which serve no purpose that we know anything about. The insects are rarely seen on plants, but where an overflow occurs millions of them are sometimes found upon the surface of the water, on which they hop about as easily as on land. Certain others are sometimes found on the surface of snow, in midwinter. The species live on dead or decaying vegetable substances and upon fungi, and in turn furnish food for a great many kinds of predaceous forms." (Smith.) None of them are of material economic importance.

The next higher order of insects is called the *Pseudoneuroptera*. It includes the dragon flies, May flies, stone flies and similar forms. These insects have four membranous net-veined wings, with biting mouth parts and incomplete transformations. The life history of the common dragon fly may serve to illustrate the biology of this group. The eggs are laid on the stems or leaves of aquatic plants by the adult dragon flies, and soon hatch into small larvæ that live in the water, preying upon mosquito "wrigglers" and other aquatic insects. They are provided with a kind of triangular-shaped jaw, with a sharp pair of scissors at the end;



PLATE II. TRANSFORMATIONS OF A DRAGON FLY.

this is called the mask. It is usually concealed under the head of the larva, but when an insect comes within reach it is suddenly thrust out, grasps the victim and returns to its concealed position. The larva grows gradually, and finally crawls up out of the water on some reed, when its skin splits open along the back and the adult dragon fly appears. These insects are predaceous in all stages of their existence.

The order of insects to which grasshoppers, crickets, katydids and similar creatures belong is called the *Orthoptera*, a word meaning straight-winged. The insects of this order have four wings, the first pair being thickened, and, when at rest, overlapping the second, which are folded in longitudinal plaits. The transformations are incomplete, the young resembling the adults in general appearance. The mouth parts are formed for biting rather than sucking.

The first important family of the *Orthoptera* is that of the cockroaches (*Blattidæ*). There are many species of them, the most abundant probably being the oriental cockroach and the so-called Croton bug. "Cockroaches are very general feeders; they destroy nearly all forms of provisions and injure many other kinds of merchandise. They often deface the covers of cloth-bound books, eating blotches upon them for the sake of the sizing used in their manufacture; and I have had them eat even the gum from postage stamps. They thrive best in warm, damp situations; in dwellings they prefer the kitchens and laundries, and the neighborhood of steam and water pipes. They are chiefly nocturnal insects. They conceal themselves during the day beneath furniture or the floors, or within the spaces in the walls of a house; and at night they emerge in search of food. The depressed form of their bodies enables them to enter small cracks in the floors or walls."*

*Comstock.

After the cockroaches follow two families of peculiar insects. The first includes the soothsayers or praying mantes, and the second the walking sticks. The for-



FIG. 8. BIRD GRASSHOPPER OR AMERICAN LOCUST.

mer are found especially in warm climates, at least one species occurring commonly in our Southern States



FIG. 9. A KATYDID.

The walking sticks also are most abundant in the tropics, although one species occurs in the Northern States.

The common grasshoppers or locusts belong to the family *Acrididæ*, a large group containing many injurious species. The hind legs are long and stout, fitting the insect for jumping. The largest species inhabiting the United States is the bird grasshopper, or American locust, represented natural size in Fig. 8. This handsome insect might readily be mistaken for a small bird when it is flying at a distance. It inhabits the Southern States, occasionally occurring as far north as Central Ohio. Accounts of other species will be found in the later pages of this book.

The family *Locustidæ* includes the long-horned grasshoppers and katydids. These insects especially abound during the late summer and early autumn



FIG. 10. THE BLACK CRICKET.

months, when their familiar sounds greet us on every side. Most of the insects of this family are green in color, to correspond with the herbage among which they live.

The crickets which form the family *Gryllidæ* are abundant everywhere in fields and meadows, and probably do considerably more damage than they are usually credited with. In the Northern States the common

black species generally winter over in the condition of eggs which are deposited in the ground. The climbing or tree crickets and the burrowing or mole crickets are abnormal members of this family.

The order *Hemiptera* includes the true bugs. They have four wings, sucking mouth parts and incomplete transformations. Here belong the bark lice, the aphides, the tree hoppers, the various plant bugs and many others. The most notorious plant-destroying species of this order is the chinch bug. The appearance of a typical member of this order is represented in Fig. 11.

The moths and butterflies form the order *Lepidoptera*, or scaly-winged insects. Under the microscope the wings of these are seen to be covered with minute scales which overlap one another. They have complete transformations and, in the adult state, sucking mouth parts. They are divided into a large number of families, the most important of which are the following:



FIG. 11.

The various families of butterflies are grouped together under the name *Rhopalocera*. The adults are mostly day fliers and the larvæ, as a rule, live upon green vegetation. The life history of the asterias butterfly already described is typical of this group.

The family *Sphingidæ* includes a considerable number of injurious insects, of which the common tomato worm is a familiar example. The adults of this group are large-bodied moths, having long sucking tubes, and strong wings adapted to swift flight. They fly at dusk, visiting flowers in search of nectar, and depositing eggs on their various food plants. The larvæ are voracious, attaining a large size, and pupating in a hollow cell in the soil.

The family of silk-spinning moths, *Bombycidae*, includes a number of the most injurious insects affecting fruit and shade trees. The larvæ of this group are hairy caterpillars, which feed upon leaves, and when full grown spin silken cocoons for protection in the pupal state. The tent caterpillar of the apple and cherry, the fall webworm, the tussock caterpillar, the cecropia and polyphemus moths and many similar insects belong here.

The family of night-flying moths (*Noctuidæ*) includes a large number of very destructive species. The cutworms, army worm, wheat-head worm, zebra caterpillar and many other destructive caterpillars belong here. In general the larvæ have smooth skins, and pupate at or near the surface of the soil. The moths are of medium size, and as a rule fly only at night.

There is a large family of small moths called *Tortricidæ*, the larvæ of which are commonly known as leaf rollers. The normal habit of these little caterpillars is to feed upon the surface of leaves, which they roll into a protective covering; sometimes they live singly, and sometimes a number live together in a common nest. These caterpillars attack the leaves of nearly all our fruit and ornamental trees, although as a rule they do little damage. Some species, like the codling moth, feed upon fruit.

The family of looping or measuring caterpillars, *Phalaenidæ*, includes the destructive cankerworm among its members. Many of the larvæ of this group so closely resemble twigs as to be difficult to detect in their natural habitat. The adult moths have slender bodies and comparatively large wings, although sometimes the females are wingless.

To the *Diptera* belong the two-winged flies; the common house fly is an excellent example. These insects undergo complete transformations, have sucking

mouth parts, and exhibit a great variety in their habits of life. Many live in filth of various kinds; others are aquatic; others develop in plant tissues, and yet others are parasitic on the higher or lower animals.

The *Coleoptera* or sheath-winged insects form the immense order which includes the beetles. The front wings are hardened into horny cases which cover and protect the membranous second pair; the mouth parts are formed for biting and the transformations are complete. In the larval state the beetles are commonly called grubs. Many beetles are destructive to vegetation, while a few live upon decaying organic matter and others prey upon other insects. Only a few of the more important families can here be mentioned.

The tiger beetles form a distinct family (*Cecindelidæ*) the members of which devour many other insects, being predaceous in both the larval and adult states. These beetles are often brightly colored and marked with distinct spots. Their form when magnified is shown in Fig. 12. They are abundant in sandy situations, and may commonly be seen running along country roads or by the side of streams.

The ground beetles of the family *Carabidæ* form one of the largest groups of this order. The commonest species of the family are the elongate black beetles found abundantly under boards and stones, resembling Fig. 3 *b* in general shape. These beetles vary much in habits: some of them, especially those belonging to the genus *Harpalus* and its allies, feed largely upon vegetation of



FIG. 12. TIGER BEETLE.
Magnified.

various kinds, while others, particularly those of the genus *Calosoma* and nearly related genera, are strictly carnivorous, being excellent examples of predaceous beetles.

Many insects destructive to cultivated crops are found in the great family of leaf beetles or *Chrysomelidæ*, which is said to include more than ten thousand described species. The most notorious American member of this family is the Colorado potato beetle, but there are many others, such as the corn-root worms, the various flea beetles, the striped cucumber beetle, the asparagus beetle, and others equally injurious. The larvæ of this group vary much in life history and appearance: some live exposed on leaves, others are leaf miners, and others live on roots under ground.



FIG. 13.
A LEAF
BEETLE.

A large number of injurious insects are found among the snout beetles of the family *Curculionidæ* and its allies. The plum and apple curculios, the bean and pea weevils, the various grain weevils, the corn billbugs, the white-pine borer, and many others belong here. The larvæ of these insects are usually footless grubs, and have varied feeding habits. The adults have a habit of dropping to the ground when disturbed, drawing their legs against the body and remaining quiet for some time: many of them thus resemble particles of rubbish

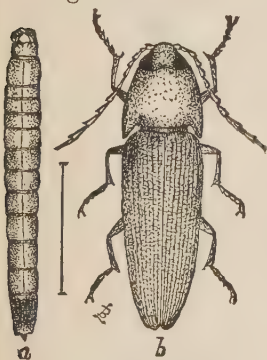


FIG. 14. CLICK BEETLE.
a, larva (wireworm); b, beetle.
Magnified.

which commonly occur on the soil surface and thus elude the observation of birds or other enemies.

The hard cylindrical yellow worms frequently found in the soil of meadows and grainfields, and commonly

called "wireworms," are the larvæ of the click or snapping beetles of the family *Elateridæ*. These larvæ feed upon the roots of plants and sometimes do serious damage to young corn and wheat. They are difficult to combat by artificial methods.

The common May beetle or June bug belongs to a family—*Scarabeidæ*—which contains many other well-known depredators. This insect is the fully developed condition of the white grub or "grubworm" so often found in pasture and meadow lands. The rose beetle, the spotted grapevine beetle, the "tumblebugs" and many others belong to this family.

The ants, bees, wasps, sawflies and various four-winged parasites combine to form the order *Hymenop-*



FIG. 15. AN ICHNEUMON FLY. a, larva; c, pupa; d, adult, magnified.

tera. These insects have the jaws fitted for biting while the other mouth parts are fitted for sucking. The transformations are complete, and there are with few exceptions two pairs of membranous wings having comparatively few veins. This order includes some highly beneficial as well as very injurious species.

Probably the most important group of parasitic insects is that comprising the families Braconidæ and Ichneumonidæ of modern entomologists. These little creatures vary greatly in life habits, but a large proportion of them are primary parasites of injurious insects. The adults are four-winged flies with slender bodies and antennæ, and the larvæ are soft, fleshy, footless grubs. Many of the females are provided with long exerted ovipositors, with which they can reach caterpillars hidden in trunks of trees or stems of herbaceous plants. The eggs are usually deposited on or in the body of the larva selected as the victim. They soon hatch into grubs that develop at the expense of the tissues of the hosts. Some of the grubs are internal parasites, living beneath the skin of the caterpillar, while others attach themselves externally. In either case the host is doomed: it may be killed long before it gets its full larval growth, or may be allowed to complete that growth and even spin a cocoon, but sooner or later the parasites, like the fox in the fable, will gnaw away its vitals. When the parasitic grubs become fully grown they generally spin slight silken cocoons within which they change to pupæ to emerge later as adult flies.

METHODS OF PREVENTING INSECT INJURIES

The methods of preventing insect injuries may conveniently be grouped together in four general classes, viz. : (1) Agricultural Methods ; (2) Mechanical Methods ; (3) Use of Natural Enemies ; (4) Insecticidal Methods.

The chief agricultural methods by which the injuries of noxious insects may be prevented are the following:

Clean Culture.—There is probably no one general method by which the farmer can do more to protect his crops from insect injury than by clean culture. A large proportion of injurious insects pass the winter under

rubbish of many sorts the burning of which late in fall will lead to their destruction. If the rubbish is not allowed to accumulate such insects will have less chance to find suitable quarters, and will be more likely to perish from the effects of weather. Clean culture also reduces the opportunity of feeding and breeding, and enables one with greater certainty of success to apply insecticides or other methods of destruction. "It is a safe rule," writes Prof. J. B. Smith, "whenever a crop is gathered, to clear off the remnants and destroy them as completely as possible. This is contrary to the general practice, which is to get the crop and let the remnants take care of themselves, until the land is prepared for something else. Melon, citron, squash, cucumber and other similar vines are simply left in the fields after the crop is gathered, and there many a borer and many a striped beetle comes to maturity long after the farmer is done with the plants. The rule should be to gather and burn, either by fire or in the manure pit with lime.

"In orchards, this recommendation is of especial importance. In dead wood, on the tree or on the ground, many species hide or complete their development during the winter. Every dead branch and twig should be cut, and with the other rubbish hauled out and burnt. The ashes will make a good fertilizer. Rubbish is never a source of advantage, and may be the exact contrary in many instances. Loose bark does not help a tree much, while it does afford shelter to many hibernating species. Never leave an old wood pile in or near an orchard, especially if the wood is of the same kind as the orchard trees. Many insects breed preferably in dead wood; but when it becomes too dry or too rotten, they have a sharp instinct that enables them to discover a weak or sickly tree, and they attack this at once and ruin it, where otherwise it might recover. Fallen fruit should *always* be destroyed. Were this systematically

done, there would soon be no further complaint of curculio, and less of codling moth. The fruit should be fed to hogs, buried deeply, burned with quicklime, or disposed of in some other way that will prevent its maturing the contained insects. Field and orchard should contain, as nearly as possible, nothing save the crop, and when no crop is on the ground there should be nothing else—certainly neither rubbish nor remnants.”

Crop Rotation.—By a thoroughgoing system of crop rotation the multiplication of many insect pests is effectually prevented. This process may act by starving the pests as in the case of the western corn-root worm, an insect which deposits eggs in the cornfield in autumn, the eggs hatching into worms the following spring. If then no corn is present the worms perish. Or the process may compel the insect to feed upon scattering weeds and grasses as in the case of the corn-root louse, thus giving a decided check to its powers of multiplication. There are many and cogent reasons for crop rotation besides those relating to insects, and good farmers seldom plant a given crop on the same ground for successive years. “Good agriculture” says Professor S. A. Forbes “is the first and best insecticide.”

Fall Plowing.—The injuries of many insects may largely be prevented by fall plowing. The pests affecting the roots of grasses and grains are largely subject to injury by this method which exposes them in one stage or another to the attacks of birds and other enemies, as well as to washing and freezing by the elements and injury by other methods.

Fallowing.—Summer fallowing may sometimes be used to advantage in starving out certain pests, although its adoption is seldom necessary.

Refraining from Culture.—Sometimes when a crop pest of the first class—such as the chinch bug—becomes overwhelmingly abundant over a wide area, it is

desirable to refrain for one or two years from the culture of the crops upon which the insect develops. The successful carrying out of this method involves the co-operation of the farmers of a large district.

Fertilizing.—It is a well-established general rule that a plant is better able to resist insect attack when it is in a thrifty, growing condition than when it is weak in vitality. Consequently such fertilization as will bring about the healthiest growth of the crop is desirable. Some fertilizers also have a direct insecticidal value: kainit, nitrate of soda, and tobacco are good examples. Root lice are effectually destroyed by these substances. Professor J. B. Smith, who has paid special attention to the insecticidal value of fertilizers, makes this recommendation: "Whenever potash is to be put on as a fertilizer, use it, if possible, in the form of kainit and as a top-dressing as soon as the ground is prepared and *before* the crop is in; use nitrogen in the form of nitrate of soda, also as a top-dressing, and just when you want your plants to have it."

Selection of Resistant Varieties.—It has long been observed that some varieties of fruits, vegetables and grains are more subject to insect attack than others. Consequently other things being equal it is advisable to select such varieties for planting.

Modifying the Time of Planting.—Sometimes insect attack may easily be prevented by planting the crop either earlier or later than the customary time. In such cases a careful study of the limits in either direction may well be made, and all possible advantage taken of the facts.

Modifying the Time of Harvesting.—Some species of insects may be controlled by bringing the crop to maturity earlier or later than usual. A study of time limits in this case is also advisable and an intelligent procedure based upon such knowledge may be adopted.

Use of Food Plants as Traps.—A number of insect pests may be best destroyed by planting a favorite food plant near the crop to be protected: the insects will concentrate upon this and may then be destroyed. A good example of this is found in the practice of sowing mustard between rows of cabbages in order to attract the harlequin bug to the former where it may be destroyed and the cabbages thus be protected.

MECHANICAL METHODS

The more important mechanical methods of controlling insect depredations may be summarized as follows:

Hand Picking.—The simplest way of preventing injury by many insects is to pick them off by hand and kill them. Large caterpillars like the tomato worm and other sphinxes are generally to be located because of the foliage devoured and are easily destroyed. The tent caterpillar and orchard webworm are also readily picked off when the insects are young and their nests small. In the garden and on the home grounds this method should be constantly in use, and often in the case of certain crops it is the cheapest and most effective way of ridding larger plantations of insect enemies.

Catching by Nets or other Devices.—It is sometimes practicable to catch injurious insects by means of a net of gauze similar to the collecting net of the entomologist. This is simply a gauze bag attached to a ring on the end of a handle. It has been recommended for use on large cabbage plantations in catching the early brood of cabbage butterflies and thus preventing deposition of eggs that would hatch into cabbage worms. Another mechanical device that has proven useful is a stiff square of cardboard smeared on each side with tar. This is used to catch the leaf hoppers affecting grapevines—the cards being waved through

the air in which the insects are flying. Another mechanical device is the so-called hopper dozer, by means of which insects affecting grass lands are destroyed. There are various other similar mechanical means sometimes used in insect destruction.

Excluding by Mechanical Means.—Often the most practical way of preventing insect injury is to fence out unwelcome visitors by mechanical devices. The bagging of grapes and the covering of young cucurbitaceous vines with netting are good examples of this method.

Catching by Jarring and Beating.—Insects affecting the fruit or foliage of trees may sometimes be induced to fall to the ground by sudden jars of the trunk or larger branches. They may then be killed in various ways. One of the commonest methods is, to spread beneath the tree sheets of cloth, either loose upon the ground or stretched upon various kinds of frames. The plum curculio is the species most commonly fought in this way. Sometimes the foliage of vines may be beaten to dislodge insect enemies.

Attracting to Light.—Many insects fly to light; advantage is sometimes taken of this to destroy moths or other parents of noxious insects. This may be done by lighting bonfires, placing a lantern over a tub of water, or by a trap similar to the one shown in Fig. 16, the pan containing water with a film of kerosene on top.

Trapping.—Insects are trapped in many ways by means of mechanical devices. Cutworms and squash bugs will congregate under chips or small boards placed

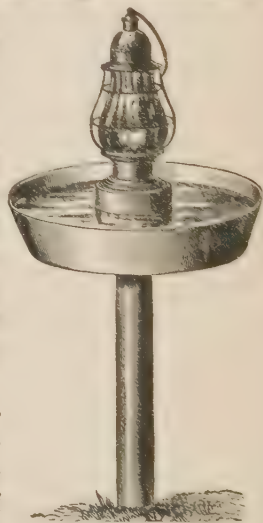


FIG. 16. LANTERN TRAP.

in infested fields, and are then easily killed. Codling-moth larvæ may be entrapped under boards placed loosely around the trunk of the trees. Chinch bugs and army worms may sometimes be caught in holes or ditches dug in their paths, and may also be prevented from crossing into fields by the use of tar so arranged as to form a line which the insects cannot cross. Tarred paper may also be put around trees to prevent the ascent of pests like the cankerworm.

Inundating.—In the case of certain crops it is possible to prevent insect injury by flooding the field. The cranberry is the best example of this. It is a simple and efficient method.

THE USE OF NATURAL ENEMIES

An intelligent understanding of the use of natural enemies in keeping in check injurious insects necessitates a knowledge of certain general biological laws which govern the case. The most important of these is probably the one which is commonly stated in this way: No animal can multiply beyond the limits of its food supply. The truth of this is obvious; but it is often overlooked in discussions concerning the use of parasites in subduing insect outbreaks. It is so important that the interrelations of host and parasite be clearly understood that I quote at length from an admirable essay by Professor S. A. Forbes, in which these relations under *natural* conditions are discussed:*

“Evidently a species cannot long maintain itself in numbers greater than can find sufficient food, year after year. If it is a plant-feeding insect, for example, it will soon dwindle if it seriously lessens the numbers of the plants upon which it feeds, either directly by eating them up, or indirectly by so weakening them that they

*On Some Interactions of Organisms, *Bulletin, Ill. State Laboratory of Natural History, I, No. 3, 1880.*

labor under a marked disadvantage in the struggle with other plants for foothold, light, air and food. The interest of the insect is therefore identical with the interest of the plant it feeds upon. Whatever injuriously affects the latter equally injures the former, and whatever favors the latter equally favors the former. This must therefore be regarded as the extreme normal limit of the members of a plant-feeding species,—a limit such that its depredations shall do no especial harm to the plants upon which it depends for food, but shall remove only the excess of foliage or fruit, or else superfluous individuals which must either perish otherwise, if not eaten, or surviving, must injure their species by overcrowding. If the plant feeder multiply beyond the above limit, evidently the diminution of the food supply will soon react to diminish its own numbers; a counter reaction will then take place in favor of the plant, and so on through an oscillation of indefinite continuance.

“On the other hand, the reduction of the plant-feeding insect below the normal number will evidently injure the food plant by preventing a reduction of its excess of growth or numbers, and will also set up an oscillation like the preceding except that the steps will be taken in reverse order.

“I next point out the fact that precisely the same reasoning applies to predaceous and parasitic insects. Their interests, also, are identical with the interests of the species they parasitize or prey upon. A diminution of their food reacts to diminish their own numbers. They are thus vitally interested in confining their depredations to the excess of individuals produced, or to redundant or otherwise unessential structures. It is only by a sort of unlucky accident that a destructive species really injures the species preyed upon.

“The discussion thus far has affected only such organisms as are confined to a single species. It remains

to see how it applies to such as have several sources of support open to them,—such, for instance, as feed indifferently upon several plants or upon a variety of animals or both. Let us take, first, the case of a predaceous beetle feeding upon a variety of other insects,—either indifferently upon whatever species is most numerous or most accessible, or preferably upon certain species, resorting to others only in case of an insufficiency of its favorite food.

“It is at once evident that, taking its food insects as a unit, the same reasoning applies as if it were restricted to a single species for food: that is, it is interested in the maintenance of these food species at the highest number consistent with the general conditions of the environment,—interested to confine its own depredations to that surplus of its food which would otherwise perish if not eaten,—interested, therefore, in establishing a rate of reproduction for itself which will not unduly lessen its food supply. Its interest in the numbers of each species of the group it eats will evidently be the same as its interest in the group as a whole, since the group as a whole can be kept at the highest number possible only by keeping each species at the highest number possible.”

Professor Forbes goes on to show that when the rate of reproduction of a parasite is relatively too great it causes fluctuations in numbers which are injurious both to the parasite and its host, and concludes that in a state of nature “the annihilation of all the established enemies of a species would, as a rule, have no effect to increase its final average numbers.”

Such being the case where man has not interfered with nature, we have next to inquire to what extent these principles hold good under the conditions of modern agriculture, for those insects which feed upon cultivated crops. Evidently a chief element of disturbance

of the natural order here lies in the enormously increased food supply—an increase so great and so subject to multiplication by man that it is a rare event for an insect to reach its limit. If a crop in a given locality is destroyed by insects, seed from another region is usually planted the following season, so that while under natural conditions the insect would have been starved out, it is instead given an increased opportunity to develop. In consequence of this, the law that no animal can multiply beyond the limits of its food supply becomes practically inoperative.

Given then this condition of a plant-feeding insect with a practically unlimited food supply to draw upon, we have next to consider what relations it would sustain to its parasitic enemies. We may take as an example the common tomato sphinx caterpillar (*Phlegethontius celeus*) and its microgaster parasite (*Apanteles congregatus*). The latter is a small, black, four-winged fly, that deposits eggs beneath the skin of the tomato worm, especially along the back. The eggs hatch into little maggots that absorb the body juices of the worm, developing at its expense and finally coming out upon its back where they spin white, silken cocoons, within which they change to pupæ. Shortly afterward they again change to flies, that gnaw out of the cocoons, and fly away to continue the work of destruction. The caterpillar lingers a while in a half-dead condition and finally dies.

The reproductive rate of the parasite appears to be somewhat greater than that of the sphinx; we will suppose it to be one-third greater—that, for example, each sphinx moth deposits forty eggs and each microgaster fly sixty. Suppose that in a given locality at a given time, the sphinx moths are just as numerous as the microgaster flies,—for instance that there are one hundred moths and one hundred flies. Each of these moths

deposits on the tomato plants forty eggs, so that 4,000 caterpillars will shortly hatch. When the latter are about half-grown, the one hundred flies appear among them and each deposits, *in a single caterpillar*, sixty eggs; they thus doom at once one hundred of the 4,000 caterpillars. Consequently there go into the pupal state 3,900 tomato worms to emerge as moths for the second generation. There will appear as the second generation of flies 6,000 specimens. The second brood of moths will bring forth 156,000 ($3,900 \times 40$) caterpillars. Six thousand of these will be destroyed by the microgasters, leaving 150,000 to go into the pupal state for the third generation of moths. The third brood of parasites will consist of 360,000 individuals. In this way the two species continue reproducing for several succeeding generations, the microgasters constantly gaining on their hosts, until finally a point is reached where there are as many parasites as caterpillars. There will then evidently be a great and sudden check upon the latter: all of those which the parasites are able to find being destroyed, while only those few which escape parasitism will survive. In the next succeeding generation there will be very few caterpillars present—simply the progeny of the survivors just mentioned—while the parasites will be sixty-fold more numerous than before. At this point, evidently, all the parasites except a very few would die off without depositing eggs, so that there would be a great and sudden decrease in their numbers. The sphinx caterpillars then begin another period of increase. In other words, while the law that no species can multiply beyond the limits of its food supply is rendered inoperative in the case of the sphinx caterpillar, it continues to act in the case of the parasite, because man does not artificially increase the food supply of the latter. Man's interposition evidently has the effect of extending and intensifying the oscillations which would occur under natural conditions.

From this view of the case it becomes evident that we cannot hope to exterminate any species of noxious insects by means of its parasites alone. On the whole, parasitic and predaceous insects are of immense service to man. Without them many plant-feeding species would multiply to such an extent that the production of certain crops would require vastly more effort than it does now. To say, as has been said, that parasitic and predaceous insects have no economic value, is to put the case too strongly. Take, for example, two crop pests of the first class—the army worm and the Hessian fly. The history of a century shows that these insects fluctuate in numbers; that there are periods of immunity from their attacks, followed by seasons when they are overwhelmingly abundant. It is universally acknowledged that in the case of the Hessian fly this periodicity is due almost entirely to the attacks of parasites, and in the case of the army worm to the attacks of parasites, predaceous enemies and infectious diseases. Remove these checks and what would be the result? The pests would keep up to the limits of their food supply and would necessitate the abandonment of the culture of the crops on which they feed. Take another case. Professor J. B. Smith has argued that “under ordinary conditions neither parasites nor predaceous insects advantage the farmer in the least;” and to prove it cites this instance: “Fifty per cent of the cutworms found in a field early in the season may prove to be infested by parasites, and none of the specimens so infested will ever change to moths that will reproduce their kind. Half of the entire brood has been practically destroyed and sometimes even a much larger proportion; but—and the ‘but’ deserves to be spelled with capitals—these cutworms will not be destroyed until they have reached their full growth and have done all the damage to the farmer that they could have done had they not been

parasitized at all. In other words, the fact that fifty per cent. of the cutworms in his field are infested by parasites does not help the farmer in the least." But obviously it does help the farmer very greatly *the next season*, for it reduces by half the number of cutworms he will have to contend with. As a matter of fact, cutworms fluctuate in numbers in a way quite similar to the army worm and the fluctuations are largely due to parasitic enemies. I have seen regions where cutworms were so abundant that grainfields were literally cut off by them as by a mowing machine, and the following season the worms were so scarce as to do practically no damage. Even the plum curculio and Colorado potato beetle are sometimes so scarce as to require no protection against them, and the presumption is in favor of the parasites as the cause of their scarcity.

But Professor Smith is right in saying that as a general rule there is too great a tendency to rely upon natural enemies to subdue insect attack. It is nearly always safer to adopt effective measures in keeping pests in check than to trust to the chance of their natural enemies subduing them. As Dr. C. V. Riley has pointed out, "there are but two methods by which these insect friends of the farmer can be effectually utilized or encouraged, as, for the most part, they perform their work unseen and unheeded by him, and are practically beyond his control. These methods consist in the intelligent protection of those species which already exist in a given locality, and in the introduction of desirable species which do not already exist there."

Various special methods of protecting existing parasites will be described on the following pages. In general it may be said it frequently happens that some outbreaks of insects—plant lice, for example—which have reached a point where the enemies are overwhelmingly abundant had better not be treated with insecticides,

because in such cases the enemies will check the outbreak and not destroy themselves.

The second method of utilizing parasitic and predaceous enemies of injurious insects—that of introducing them to new localities—can sometimes be used to advantage in certain exceptional cases, but its practical value has been greatly overestimated in recent years by the general public. The most remarkable instance of the use of this method is the famous one in which the *Vedalia* lady beetle was introduced into California to subdue the fluted scale (*Icerya purchasi*). This latter insect was introduced from Australia into California. It there soon became a very troublesome pest because of “its ability to survive for long periods without food, to thrive upon a great variety of plants and to move about throughout most of its life.” In its native home this pest was to a great extent kept in check by its natural enemies; in America it multiplied enormously with no checks upon its increase. Through the efforts of Dr. Riley expert entomologists were sent to Australia to study the enemies of the fluted scale, and to send to California such of these as might prove useful. Various enemies were found and forwarded, but “one of them, *Vedalia cardinalis*, proved so effective as to throw the others entirely into the shade and to render their services really unnecessary. It has, so far, not been known to prey upon any other insect, and it breeds with surprising rapidity, occupying less than thirty days from the laying of the eggs until the adults again appear. These facts account for its exceptionally rapid work, for, in point of fact, within a year and a half of its first introduction it had practically cleared off the fluted scale throughout the infested region.”*

But the very fact that this lady beetle feeds only on

*Riley.

the fluted scale will in the course of time render it less useful than if it had a slightly wider range of food. For it will necessitate a fluctuation in the numbers of parasite and host according to the principle already explained; unless, indeed, and this seems a probable contingency, the lady beetles learn to feed upon other insects and thus greatly extend the limits of their food supply.

One of the most promising methods of utilizing parasites is that of their distribution from a section in which an outbreak of a crop pest is reaching its maximum, and in which, consequently, the parasites are abundant, to a region where the pest is on the increase and threatening an outbreak. Such disseminations would naturally be brought about through the official entomologists in the various parts of the country.

THE USE OF CONTAGIOUS DISEASES

It has long been known that at certain periods in the fluctuations of such insects as the army worm and chinch bug fatal maladies often appear among them, destroying them with great rapidity. The idea of cultivating the germs of these diseases and then distributing them in regions where the diseases have not yet appeared was first scientifically elaborated by Professor S. A. Forbes, State Entomologist of Illinois, who has devoted years of the most painstaking investigation to contagious insect diseases. The subject has also been taken up by Professor F. H. Snow of the University of Kansas, who has conducted extensive field experiments in the practical utilization of disease germs. Without attempting an adequate discussion of the method, it may here be said that in general two classes of these diseases are recognized—one being due to the presence of bacteria of various supposed species, and the other to certain fungi belonging to *Entomophthora*, *Sporotrichum* and other genera.

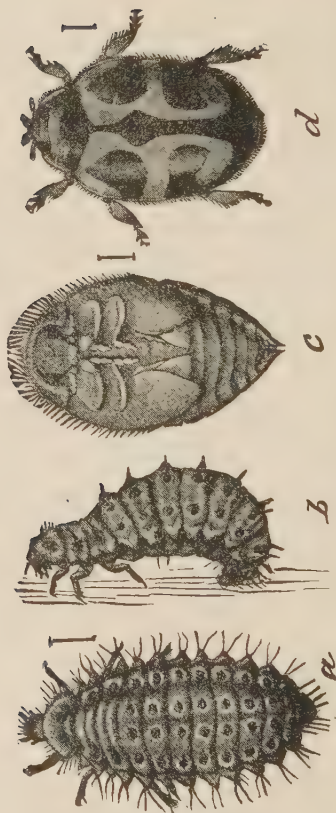


PLATE III. THE VEDALIA LADY BEETLE. *a*, larva, back view; *b*, larva, side view; *c*, pupa; *d*, beetle. Magnified.

The method of utilizing these diseases is to cultivate artificially the organism causing the malady, and then to distribute it in the field. In the case of the chinch bug the fungus is sometimes cultivated by putting some of the dead bugs in a box or vessel with a lot of living healthy ones: the latter become infected and are then scattered in the fields infested by chinch bugs. Another and probably better method is to cultivate the germs in some nutrient solution on a large scale, and then to spray or otherwise distribute it over the infested fields.

There seems to be no question but that while the benefits to be derived from this method have been greatly overestimated in the popular mind, it is capable of much good under favorable conditions. The chief trouble found as yet has been due to weather unfavorable to the development of the disease-producing organism.

THE USE OF INSECTICIDES

In the great majority of cases the most effective method of preventing insect injuries lies in the intelligent application of insecticides, or insect-killing substances. These may be broadly divided into two classes: (1) internal poisons, or those which take effect by being eaten along with the ordinary food of the insect; and (2) external irritants, or those which act from the outside—closing the breathing pores, or causing death by irritation of the skin. Besides these, however, various other substances are used in preventing insect attack—keeping the pests away because of offensive odors, or acting simply as mechanical barriers.

The most important insecticides are the poisons. Of these the most popular are the various combinations of arsenic known as Paris green, London purple, arsenate of lead, and a large number of patent insecticides sold under various names.

Paris Green is a chemical combination of arsenic

and copper, called aceto-arsenite of copper. It contains usually from fifty-five to sixty per cent. of arsenic, and retails at about thirty cents per pound. It is practically insoluble in water, and may be applied either dry or wet. In the former case for certain crops it should be well mixed with some fine powder as a diluent: plaster, air slaked lime, flour, road dust, and finely sifted wood ashes, all answer the purpose fairly well, though lime or plaster is usually preferable. The proportion of poison to diluent varies greatly with different users—one part poison to twenty, and even fifty, of diluent, will usually be effective, if the mixing be *thoroughly* done. Paris green is almost insoluble in water; but there is often a small percentage of it soluble, and to prevent the injury this may do to foliage it pays to add a little fresh lime-water (made by slaking fresh lime in water) to the spraying mixture. It may be used in spraying potatoes, apple trees, and most shade trees, at the rate of four or five ounces to fifty gallons of water. On stone fruits, especially peach, use half this strength, unless lime is added. In preparing, a good plan is to dish out the poison, then add to it something more than double the amount of freshly slaked lime; then make into a paste with a little water and add to the whole amount of water, straining through some suitable sieve.

Paris green is a heavy powder and does not stay long in suspension; hence it must be kept constantly stirred to prevent its settling to the bottom of the vessel. Buy it in as finely powdered condition as possible, and get it of a reliable dealer. It can be purchased in cans holding fourteen pounds or more, at twenty cents per pound, and ordinarily retails at a slightly higher figure.

The true Paris green (the copper aceto-arsenite) is known in the arts as Schweinfurt green, Emerald green, Mitis green and French green. "Scheele's green, the simple arsenite of copper, is frequently confounded with

Paris green, but is distinguished from the latter by its duller color and the entire absence of acetic acid, which is a characteristic constituent of a genuine Paris green.”*

London Purple is a by-product obtained in the manufacture of aniline dyes. It generally contains nearly the same percentage of arsenic as Paris green, which, however, is often in a more soluble form, and consequently it is more liable to injure foliage than is Paris green. It is a finer powder than the green, and hence remains in suspension in water much longer. It is also cheaper, retailing at about fifteen cents per pound, and in large quantities is obtainable at ten cents per pound. It may be used in the same way—as a powder or in water suspension—and the proportions given above answer very well for it. Before using, the soluble arsenic should be made insoluble by the addition of lime-water. One of the best ways to do this is to add three-fourths of a pound of lime to a pound of London purple, and thoroughly mix them in a gallon of hot water, allowing the mixture to stand two hours, and keeping it hot during this time if it can be conveniently done. In this way the soluble arsenic will be rendered insoluble, and the London purple may be used at the rate of four or five ounces to a barrel of water. Or the London purple may be added to the water as usual, and about two gallons of fresh milk of lime (made by slaking lime in water) strained into the barrel. If allowed to stand an hour, all the soluble arsenic is more likely to be rendered insoluble than if used at once. After London purple has been thus treated with lime it can safely be applied to tender foliage at a strength of four ounces to fifty gallons of water. Both London purple and Paris green may be added to the Bordeaux mixture (four ounces poison to fifty gallons mixture), as described more fully

* H. H. Ross.

on page 51, and then the treatment with lime is not necessary.

Arsenate of Lead.—This substance has recently been used successfully by the Massachusetts Gypsy Moth Commission for the destruction of caterpillars. Its chief advantage lies in the fact that it can be applied in heavy doses to tender foliage without injury to the latter. Mr. C. L. Marlatt says: "This insecticide is prepared by combining, approximately, three parts of arsenate of soda with seven parts of acetate of lead. These substances unite chemically and form a fine, white powder which remains easily in suspension. As now used by the Commission, ten pounds of the arsenate of lead are used with one hundred and fifty gallons of water, two quarts of glucose being added to cause the insecticide to adhere longer to the leaves. Prof. Fernald's experience and our own would indicate that from one-fourth to one-half this strength will answer for most larvæ—the larvæ of the gypsy moth proving to be unusually resistant to the action of poisons. The arsenate of lead costs the Commission seven cents a pound wholesale, and glucose sixteen dollars a barrel."

White Arsenic is sometimes recommended as an insecticide but, fortunately, is rarely used. It is much more dangerous to have around than the highly colored insecticides, because of the danger of mistaking it for edible products; and unless applied as soon as it is mixed with water it is very liable to burn the foliage.

The principal substances used for killing insects by contact are the following:

Hellebore is a powder made of the roots of a plant called white hellebore (*Veratrum album*). It is a vegetable poison, but much less dangerous than the mineral arsenical poisons, and kills both by contact and by being eaten. It may be applied as a dry powder or in water, an ounce to three gallons. It retails at about twenty-

five cents per pound, and is especially excellent in destroying the imported currant worm.

Pyrethrum is an insecticide of recent introduction, made from the powdered flowers of plants of the genus *Pyrethrum*. There are three principal brands upon the market, known as Persian insect powder, Dalmatian insect powder, and Buhach—the latter being a California product. The greatest obstacle to the use of pyrethrum has been the difficulty of obtaining the pure, fresh article. After long exposure to air it seems to lose much of its insecticidal value. Hence dealers should purchase a fresh supply each season, and should keep it in air-tight vessels. Pyrethrum is used mainly as a dry powder or in water (one ounce to three gallons); but may also be used in the form of a tea, or a decoction, a fume, or an alcoholic extract diluted. For use as a dry powder it may advantageously be diluted with six or eight parts of flour. It is especially excellent for clearing rooms of flies and mosquitoes, and for killing the common cabbage worms. It is practically harmless to man and the higher animals.

Kerosene and Soap Emulsion.—There are two methods of preparing this in common use,—one originating with Messrs. Riley and Hubbard, and the other with Prof. A. J. Cook. Both have their advocates. According to the former it is prepared by adding two gallons of kerosene to one gallon of a solution made by dissolving half a pound of hard soap in one gallon of boiling water, and churning the mixture by forcing it back into the same vessel through a force pump with a rather small nozzle until the whole forms a creamy mass, which will thicken into a jelly-like substance on cooling. The soap solution should be hot when the kerosene is added, but of course must not be near a fire. In case soft soap is used add one quart in place of the one-half pound of hard soap. The emulsion thus made is to be diluted before using with from nine to fifteen or twenty

parts of water to one part of emulsion. The amount of dilution varies with different insects; plant lice may be killed with emulsion diluted with fifteen or twenty parts of water, while hard-bodied insects require a dilution of only nine or ten parts water. Soft or rain water should be used in diluting. If this cannot be obtained add a little lye or bicarbonate of soda; or prepare according to one of the following methods.

Professor Cook has two formulas,—one where soft soap is used and the other for hard soap. He describes them as follows:

Cook's Soft-soap Emulsion.—“Dissolve one quart of soft soap in two quarts of boiling water. Remove from fire and, while still boiling hot, add one pint of kerosene and immediately agitate with the pump as described above. In two or three minutes the emulsion will be perfect. This should be diluted by adding an equal amount of water, when it is ready for use. This always emulsifies readily with hard or soft water; always remains permanent, for years even, and is very easily diluted, even in the coldest weather and without any heating. In this last respect it has no equal, so far as we have experimented. The objections to it are,—we cannot always procure the soft soap, though many farmers make it, and it is generally to be found in our markets; and it occasionally injures the foliage, probably owing to the caustic properties of the soap. We have used this freely for years, and never saw any injury till the past season. In case of any such trouble use only one half the amount of soap—one pint instead of one quart. It works just as well.”

Cook's Hard-soap Emulsion.—“Dissolve one quarter pound of hard soap—Ivory, Babbitt, Jaxon, or whale oil, etc.—in two quarts of water; add, as before, one pint of kerosene, and pump the mixture back into itself while hot. This always emulsifies at once, and is

permanent with hard as well as soft water. This is diluted with twice its bulk of water before use. The objection to a large amount of water sinks before the fact that this secures a sure and permanent emulsion even though diluted with hard water. This also becomes, with certain soaps, lumpy or stringy when cold, so that it cannot be readily diluted with cold water unless first heated. Yet this is true with all hard-soap emulsions in case of certain soaps. We can, however, always dilute easily if we do so at once before our emulsion is cold, and we can also do the same either by heating the emulsion or diluent, no matter how long we wait."

When the undiluted emulsion, however made, is to be kept for future use, store it in a cool, dark place. When desired for use measure out the required amount and mix it with three or four parts of boiling water. Then add cold water to fill out the dilution.

This emulsion is useful in destroying a large number of insect pests, such as plant lice, scale lice, chinch bugs and similar sucking species.

Kerosene and Milk Emulsion.—The kerosene may be emulsified with milk instead of soap. One gallon of sour milk is added to two gallons of kerosene, and the mixture is churned by means of a force pump and nozzle as directed above. "The change from a watery liquid to a thick buttery consistency, much thicker than with the soap, takes place very suddenly after three to five minutes' agitation. With sweet milk difficulty will frequently be experienced, and if the emulsion does not result in five minutes the addition of a little vinegar will induce prompt action. It is better to prepare the milk emulsion from time to time for immediate use, unless it can be stored in quantity in air-tight jars, otherwise it will ferment and spoil after a week or two."* This is

*C. L. Marlatt.

to be diluted in the same manner as recommended for the Riley soap emulsion.

In applying kerosene emulsion to destroy plant mites like the red spider, it is well to add one ounce of powdered sulphur to each gallon of the diluted emulsion.

Through the investigations of Professor E. S. Goff a modification of the knapsack sprayers has been made so that kerosene can be used without emulsifying, being mechanically mixed with water at the moment of application. Experiments by Mr. H. E. Weed of Mississippi indicate that by means of the attachment "the kerosene and water are so thoroughly mixed in the act of pumping that the kerosene is as harmless to the foliage as is an emulsion of the same strength, and it is as sure death to insects." This seems a very promising advance; but recent experiments by Mr. C. L. Marlatt indicate that there are many practical difficulties encountered in using the apparatus.

Pure kerosene is frequently a useful insecticide for certain pests. It is especially valuable in destroying vermin in henhouses, and has been successfully applied to the surface of ponds to destroy the larvæ of mosquitoes, and thus prevent the development of the adults.

Fish-oil Soap.—Professor J. B. Smith and others report excellent results in the use of this substance against plant lice and similar insects. This soap is on the market at about twelve cents a pound, but according to Professor Smith it can be made much more cheaply by the following formula:

Hirsh's crystal potash lye,	.	.	.	.	.	1 pound.
Fish oil,	.	.	.	.	.	3 pints.
Soft water,	.	.	.	.	.	3 gallons.

Dissolve the lye in the water, heat to boiling, and then add the oil. It should be boiled about two hours, and when done water can be added to make up for the

loss by evaporation. For use as an insecticide it is made into a dilute suds by dissolving one pound of soap in eight gallons of water. It is less liable to injure foliage than is kerosene emulsion.

Lime Spray is made by slaking a half-peck or a peck of fresh lime in water, and pouring into a barrel nearly full of water, straining the lumps out as it enters the barrel. By means of this and the spray pump, trees and vines may be literally whitewashed. It is useful in mechanically coating plants so that certain insects will not molest them.

Resin Washes.—"These washes have proved of greatest value, particularly against red scale (*Aspidiotus aurantii*) in California, and will be of use in all similar climates where the occurrence of comparatively rainless seasons insures the continuance of the wash on the trees for a considerable period, and where, owing to the warmth, the multiplication of the scale insects continues almost without interruption throughout the year. Where rains are liable to occur at short intervals, and in the Northern States, the quicker-acting and stronger kerosene washes are preferable. The resin washes act by contact, having a certain caustic effect, but principally by forming an impervious coating over the scale insects, thereby smothering them. The application may be more liberal than with the kerosene washes, the object being to thoroughly wet the bark.

"The wash is made as follows :

Resin,	.	.	.	.	.	.	.	.	.	20	pounds
Caustic soda,	.	.	.	.	.	.	.	.	.	5	pounds
Fish oil,	.	.	.	.	.	.	.	.	.	2½	pints
Water to make	.	.	.	.	.	.	.	.	.	100	gallons

"The ordinary commercial resin is used and the caustic soda is that put up for soap establishments in large 200-pound drums. Smaller quantities may be obtained at soap factories. These substances should be finely broken up to hasten action and placed, with the

oil, in a large kettle with sufficient water to cover them. Boiling should be continued for one or two hours with occasional additions of cold water, or until the compound will mix perfectly in water instead of breaking up into yellowish flakes. The undiluted wash is pale yellow; intermixed with water it becomes dark reddish-brown. It may be kept in concentrated form and diluted as required.

“A stronger wash is necessary for the more resistant San José scale (*Aspidiotus perniciosus*), and for this the dilution should be one-third less or sixty-six and two-thirds gallons instead of one hundred. This stronger mixture is a winter wash and is only to be applied during the dormant period; in the growing season it will cause the loss of foliage and fruit.”*

Hydrocyanic Acid Gas.—“The hydrocyanic acid gas treatment of scale-infested trees has hitherto been exclusively confined to California, but recently has been introduced in the East by the Department to combat the San José scale. Briefly, it consists in inclosing the tree with a tent and filling the latter with the poisonous fumes generated with potassium cyanide and sulphuric acid. The tents are made of blue or brown drilling or eight-ounce duck and painted, or oiled with linseed oil, to make them as nearly air-tight as possible. They are placed over the trees by hand or with poles in case of small trees, but with trees over ten feet high some sort of tripod or derrick is used. The outfit for medium-sized trees—tent and derrick—will cost from fifteen to twenty-five dollars. A tent for trees twenty-six feet tall by sixty feet in circumference costs as much as sixty dollars.

“Commercial fused potassium cyanide (costing in bulk forty cents per pound), commercial sulphuric acid (at three and one-half cents per pound), and water are

*C. L. Marlatt, Bulletin U. S. Dept. Agriculture.

used in generating the gas, the proportions being one ounce by weight of the cyanide, slightly more than one fluid ounce of the acid, and three fluid ounces of water to every one hundred and fifty cubic feet of space inclosed. The generator, which may be any glazed earthenware vessel of one or two gallons' capacity, is placed within the tent under the tree and the water, acid and cyanide, the latter broken up, and put in in the order named, after which the operator withdraws from the tent. The tent is allowed to remain on the tree for one-half hour for large trees, or fifteen minutes for small ones. The treatment is best made on cloudy days, early in the morning, late in the evening, or at night. Bright hot sunlight is liable to cause injury to the foliage, which, however, may be largely avoided by using tents of dark material or painted black. Three or four men can operate six tents at once, and the expense under such conditions, not counting the cost of the outfit, need not be more than ten cents per tree." [Marlatt.]

Tobacco.—This is a very valuable insecticide for use against vermin on domestic animals, greenhouse and other pests. It may be used in the form of a decoction, a smoke, or dry. The refuse stems and powders from the cigar factories are very valuable as insecticides and fertilizers, and frequently, in the Middle Western States, they may be obtained for little or nothing. The decoction is made by boiling refuse tobacco stems or dust in water, or pouring boiling water over them. This gives a concentrated liquid which is to be diluted with cold water, until there are two gallons water for each pound of tobacco used. It is a good remedy for plant lice. A stronger formula, recommended by Mr. M. V. Slingerland, is to steep five pounds of tobacco stems in three gallons of water for three hours; then strain and dilute with enough water to make seven gallons, when the decoction is ready to use.

Potash Fertilizers.—Professor J. B. Smith has shown that kainit and muriate of potash applied as fertilizers have a decided insecticidal value against underground insects. The fertilizer is best applied just before or during rainfall.

Carbolic Acid, especially in its crude state, is valuable for various insecticidal purposes. An excellent wash for preventing the injuries of several tree borers is made by mixing one quart of soft soap, or about a pound of hard soap, with two gallons water, heating to boiling, and then adding a pint of crude carbolic acid. Carbolic-acid soaps are largely used for destroying vermin on domestic animals.

Bisulphide of Carbon.—This colorless, volatile liquid is used for destroying grain insects, ants, the grape phylloxera, and other pests that may be reached by a vapor. On exposure to air the liquid evaporates, and as the vapor is heavier than air it settles rather than rises. In fifty-pound cans the bisulphide costs ten cents a pound, though it generally retails for twice this amount or even more. It is highly inflammable, and in using it great care must be taken that no fire in any form comes near it. It should be stored in tight vessels in outbuildings, securely fastened. It is liable to injure seed grain treated with it, though it does not affect the milling quality of the grain. The liquid has a disagreeable odor, which soon completely disappears.

Benzine is another volatile substance used for much the same purposes as the last.

Gasoline may also be mentioned in the same connection.

Coal Tar has been largely used in the West for destroying Rocky Mountain locusts, being placed on flat pans, on which the insects jump and are caught. It is also employed to prevent the migrations of the chinch bug. A shallow V-shaped channel is made with the

corner of a hoe along the borders of the field to be protected, and tar poured in. So long as the tar does not dry out, the immature chinch bugs cannot cross it.

COMBINING INSECTICIDES WITH FUNGICIDES

It is often desirable to combine a fungicide with an insecticide, applying both at the same time and in the same mixture. The advantages of this are obvious. The following combinations have been found practicable:

Bordeaux Mixture and Arsenites.—Add four ounces London purple or Paris green to fifty gallons of dilute Bordeaux mixture.

“The Bordeaux mixture is made by combining six pounds of copper sulphate and four pounds of quicklime, with water to make fifty gallons. The copper sulphate is dissolved in water (hot, if prompt action is desired) and diluted to about twenty-five gallons. The fresh lime is slaked in water, diluted to twenty-five gallons, and strained into the copper solution, after which the whole is thoroughly stirred with a paddle. Both the copper and the lime mixtures may be kept in strong solution as stock mixtures, but when combined should be promptly used, as the Bordeaux mixture deteriorates on standing.” This is one of the very best combined insecticides and fungicides. It can be used safely and effectively upon a great variety of crops—such as potatoes for Colorado beetles and blight, apples and pears for insects and scab, and plums for curculio and leaf or fruit diseases.

Copper Arsenic Solution.—The Ohio Experiment Station recommends the following combination: Paris green two ounces, carbonate of copper two ounces, dissolve in three pints of ammonia, add one-half pound lime and one barrel of water. It is advised that this be substituted for the arsenite and Bordeaux combination for the later sprayings of apples, pears, plums, etc., so as to avoid the lime coating on the fruit.

Care must be taken in combining the arsenites with other fungicide solutions, as one is liable thus to produce a compound very injurious to foliage. Paris green or London purple added to simple solutions of copper sulphate, or to ammonia compounds without lime, injures foliage vastly more than in simple water mixture.

THE APPLICATION OF INSECTICIDES

The methods of applying insecticides vary according to the nature of the substance and the insect against which it is to be used. The dry powders are generally best applied by means of some powder bellows, a number



FIG. 17. POWDER GUN.

of patterns of which are upon the market. An apparatus sometimes called the dry-poison duster, which is used extensively in the south, is described by Mr. H. E. Weed. "It consists simply of two bags made of eight-ounce osnaburg cloth attached to the ends of a pole about six feet long and two inches in diameter—a hickory pole being preferred. The bags are made about a foot long and six inches deep, and are tacked to the sides of the

pole. The dry insecticide is placed within the bags by means of a hole about an inch in diameter, bored through the pole, to be stopped up with a removable plug. For cotton plants this apparatus is operated by holding in the hands when upon a mule. If the mule goes at a brisk trot the poison will be distributed evenly and rapidly. For other plants, such as the cabbage and potato, the apparatus may be held in the hand and shaken."

In many cases the best way to apply dry insecticides is by one of the so-called "powder guns," a good form of which is represented in Fig. 17.

In general, insecticides are most satisfactorily applied in a liquid state by means of a force pump and spray nozzle. There are four general styles of spraying machines upon the market. First, we have the small bucket pumps that serve a useful purpose where only a comparatively small amount of spraying is to be done; then come the knapsack sprayers, one of the best of which is illustrated in Fig. 18, which are especially useful in spraying small vineyards and crops where a horse cannot well

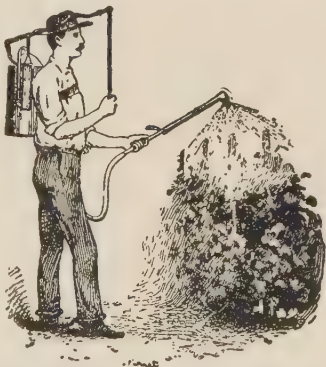


FIG. 18. THE KNAPSACK SPRAYER.

be driven; third, we have what may be called the barrel class of sprayers, being good-sized pumps to be attached to barrels mounted in various ways; and, finally, there are the large-gearred machines working automatically by horse power. For the general purposes of the average farmer or fruit grower the barrel machines are much the most useful. They are also of moderate cost, ranging from eight to sixteen dollars. They can be used in

spraying all sorts of crops, and may well be mounted on separate wheels, or the barrel may be placed in a wagon when in use.

For work in the nursery as well as many other places an excellent spraying outfit "can be made by firmly fastening a barrel, end up, on a sled made of



FIG. 19. OUTFIT FOR SPRAYING GRAPES.

heavy durable timber. Mount upon the barrel a good, strong, double-acting force pump provided with two-hose attachments, to each end of which fasten twenty-five feet of half-inch hose. To the end of each hose attach a Vermorel nozzle; then with the necessary gearing for hitching the horse, the outfit is complete. For operating the machine two men and a horse are required. One man does the pumping and attends to the horse, while the other walks behind and directs the spray over two rows at a time."*

A good outfit for use in the vineyard, recommended

* Galloway.

by Professor Bailey, is illustrated in Fig 19. A barrel with pump is mounted crosswise on the wagon, "and the driver rides and pumps. Another man walks behind and throws the spray up under the vines and on to all the clusters by means of a Vermorel nozzle attached to a half-inch gas pipe. This gas pipe has somewhat the form of a slim letter S, the nozzle being attached to



FIG. 20. INSECT NET.

one terminal crook, the other crook resting over the man's left arm. The hose is attached near the shoulder. The pipe is so long that the operator is not obliged to stoop, and he can direct the spray in any direction, while the apparatus hangs easily upon the arm. A globe valve just below the arm enables the operator to shut off the stream at will."

The nozzle forms an important part of the spraying outfit. There are many varieties of these upon the market; some of them are better adapted to certain kinds

of work than are others, so that it pays to have several forms on hand where there is a variety of spraying to be done. Some of the best forms are the Vermorel, Climax, Eureka, Graduating Spray, Mason, Bordeaux and McGowen. The latter is very good for orchard work. For spraying large trees, some method of raising the nozzle nearly to the top is generally necessary. The commonest way of doing this is to fasten the nozzle and hose to a long pole; but a better way is to use a half-inch gas pipe or a brass tube, twelve or fourteen feet long, attaching the hose at one end and the nozzle at the other, or one of the bamboo extensions manufactured by some spraying firms.

COLLECTING AND PRESERVING INSECTS

The apparatus for collecting insects for study is neither elaborate nor expensive. One of the first essentials is a collecting net, which is used for catching butterflies, moths, bees, flies, wasps, and in fact nearly all flying insects. To make it, obtain an iron wire about one-fifth of an inch in diameter, and bend it into a circular ring twelve or thirteen inches in diameter, leaving the ends projecting at right angles to the circle, and welding them together so as to form a spur three or four inches long. Fasten this spur into the end of a broomstick, or any other convenient handle three or four feet long. Then sew over this wire circle a strip of strong muslin, an inch or two wide, and to this sew a bag of mosquito netting, swiss muslin, or some similar fabric, about three feet deep. For collecting insects in ponds, a shallower net is needed, and the cloth used should be of stronger material.

After the insects are caught, some way of killing them quickly and without injury is needed. For this purpose most entomologists use what is called the cyanide bottle. To make this, obtain almost any wide-

mouthed glass bottle with a tight-fitting cork; place on the bottom two or three lumps of cyanide of potassium, the size of a hickory nut, cover these with plaster of Paris, and; finally, add sufficient water to moisten the plaster and make it set. After it is hard pour off the surplus water if there is any, and let the bottle become thoroughly dry before inserting the cork. This cyanide of potassium is poisonous, and of course must be handled carefully. If desired, the bottles may be prepared at drug stores, at small cost. After the plaster is set there is practically no danger, unless the fumes of the bottle be directly inhaled, for which there is no excuse. Keep the bottle closed except when putting in an insect. The cyanide fumes, rising through the porous plaster, will kill it almost instantly. This cyanide bottle is to be used especially for moths, butterflies, bees, wasps and similar insects, but should not be used for worms and caterpillars, which are more successfully killed and preserved in alcohol. A pair of straight, medium-sized forceps is useful in collecting small insects. A supply of ordinary commercial alcohol, and of various sizes (2, 3 and 4 dram) of short, homeopathic vials will be necessary if soft-bodied caterpillars, spiders, thousand-legged worms, etc.,

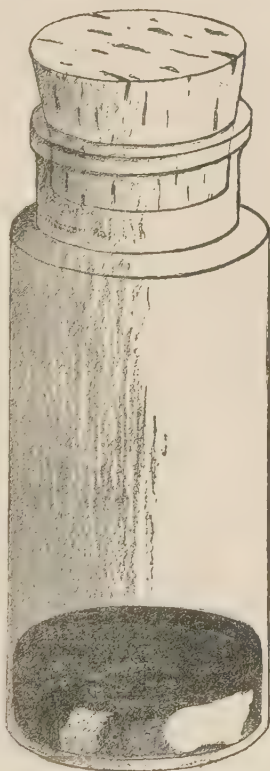


FIG. 21. CYANIDE BOTTLE.

are collected. Empty morphine bottles are very convenient. An ordinary game bag is an excellent thing to carry the bottles, forceps and other "traps" in, while out collecting.

For rearing insects to study their transformations and habits, *breeding cages* of various kinds are needed. Almost any box may be used for this purpose, covering it in part with gauze, and placing on the bottom an inch or two of moist earth, to prevent the drying of the atmosphere. Ordinary jelly tumblers are very useful for rearing small leaf-eating caterpillars, and "bell glasses" or glass shades are quite handy. The cages should be examined daily, the food frequently renewed, and the conditions which the insect would have in its natural habitat should be supplied as far as possible.

PRESERVING THE SPECIMENS

The first requisite for preserving insects is a supply of entomological pins, which are longer and usually

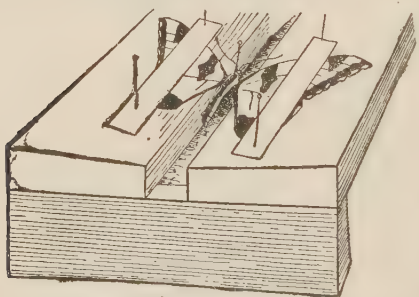


FIG. 22. SETTING BOARD.

more slender than ordinary pins, answering the purpose much better. What is known as the Klæger pin is the best made. It can be purchased of dealers in natural history supplies. These pins

vary in size, according to number. No. 2 is used only for very small insects, while No. 5 is large enough for any of our species. For the majority of specimens of moderate size No. 4 may be used. A supply of sheet-cork is also needed. This costs about fifty cents a dozen sheets, and may also be obtained of natural history supply dealers.

Butterflies, moths, and some other insects require, for their proper preservation, what is called a "setting-board," one of which is shown in Fig. 22. It consists simply of two thin strips of pine board, twelve or sixteen inches long, nailed to end pieces, with a space varying from one-fourth to three-fourths inch between the long strips; a piece of thin cork is fastened to the under-side of the strips so as to cover this space. The pin on which the butterfly is fastened is pushed through the cork until the side pieces are level with the base of the wings. The wings are then brought forward until the posterior borders of the front ones are at right angles to the body, and they are then fastened in place by pieces of cardboard held down with pins, as shown in the illustration. The insect should be left thus fastened until dry, so that the wings will remain in the position indicated. This usually requires from ten to fourteen days.

Some sort of boxes or cases in which to keep the specimens are of course necessary. The simplest and cheapest receptacles consist of empty cigar boxes, lined on the bottom with sheet-cork. Tight wooden boxes of almost any kind will also answer the purpose. Shallow drawers with the bottoms lined with cork are excellent.

The specimens must frequently be examined to see that museum pests—insects which live on dead animal tissues of all kinds—do not destroy them. When these are found, bake the specimens in an oven for an hour, at a temperature of 140° Fahrenheit.

Moths, butterflies, bees, wasps, and a large number of similar insects should be pinned through the center of the *thorax*, or middle division of the body, the pin being pushed through until about one-third of its length remains above the insect. Beetles, however, should be pinned through the right wing cover, and the true bugs through the triangular piece at the base of the wings, called the *scutellum*.

Any one desiring to learn about the classification of insects will find "A Manual for the Study of Insects," by Professor J. H. Comstock, Ithaca, New York, extremely valuable. Professor Packard's books, "Entomology for Beginners," and "Guide to the Study of Insects," which can be obtained through book dealers, will also prove helpful.

PART I

INSECTS AFFECTING ORCHARD FRUITS

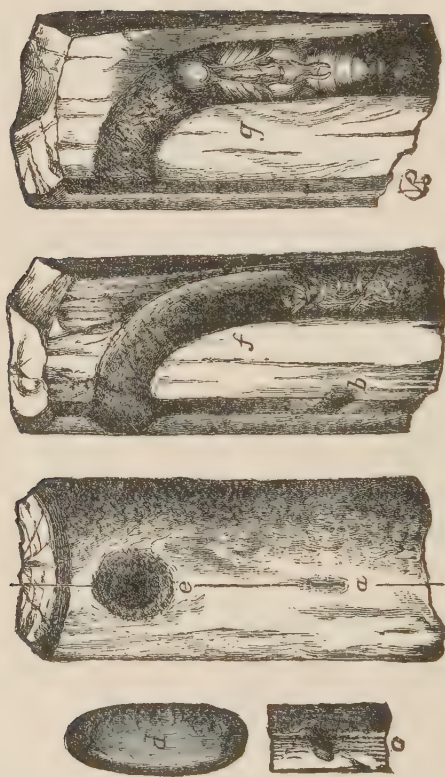


PLATE IV.—ROUND-HEADED BORER.

a, b, hole in which egg is laid; **c**, same with bark removed on one side; **d**, egg enlarged; **e**, hole made by beetle in exit; **f**, burrow of larva; **g**, same showing pupa.

INSECTS AFFECTING THE APPLE

INJURING THE TRUNK

The Round-headed Apple-tree Borer

Saperda candida

The three later stages of this insect are shown in Fig. 23. The beetle (*c*) is easily recognized by the brown color of its body, and the two conspicuous, longitudinal, whitish stripes along its back. It appears early in summer, and deposits its eggs on the tree trunks, in or under the bark, within a few inches of the ground, frequently placing them just above the soil surface, or even below it where the ground is cracked open so that the beetle can descend without difficulty. The insect makes a slit-like opening in the bark (Plate IV, *a*, *b*) into which the egg (shown magnified at *d*) is pushed. A few days later the egg hatches into a larva or grub, which gnaws its way into the inner bark or sapwood, where it continues to feed throughout the season. As winter approaches it frequently burrows downward below the surface of the ground, and rests there until spring, when it again works upward and gnaws the inner bark and sapwood as before. It rests again the following winter, and in spring gnaws its way deeper into the body of the trunk, cutting cylindrical channels in every direction. Late in summer it bores upwards and outwards to the bark, lining a cavity at the end of its burrow with dust-like castings (*f*, *g*) and there rests until spring, when it changes to the

dormant chrysalis state. The adult beetle emerges from the chrysalis about a fortnight later, eats a hole through the bark with its strong jaws, and comes forth to continue the propagation of the species. Thus three years are required for the development of the insect.

The place where the larva enters may frequently be detected, especially in young trees, by the sawdust-like castings that are pushed out. The eggs also may often be seen, and are easily destroyed by pressing on the bark surrounding them with a knife-blade or some similar instrument. The presence of the larva is shown later by the discoloration of the bark where it is at work.

The full-grown grub, or larva, of the round-headed borer is illustrated at *a*, Fig. 23. It is about an inch

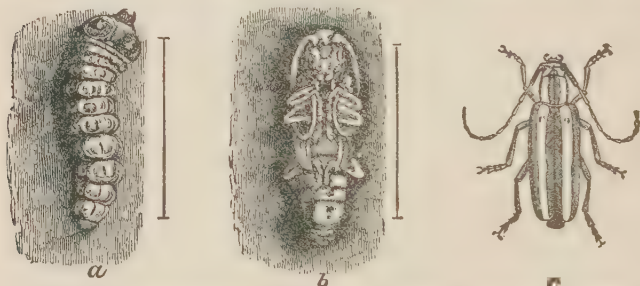


FIG. 23. ROUND-HEADED APPLE-TREE BORER. *a*, larva; *b*, pupa; *c*, beetle.

long, wholly without feet, whitish, with a chestnut-brown head and black jaws. The pupa or chrysalis (*b*) is lighter colored than the larva, and has numerous small spines on its back.

Remedies.—The injuries of this insect may be prevented by applying late in May, or early in June, and twice later at intervals of three weeks, a strong solution of soft soap to which has been added a little crude carbolic acid. This mixture may be conveniently made by mixing one quart of soft soap, or about a pound of hard soap, with two gallons of water, heating to boiling, and

then adding a pint of crude carbolic acid. It will be made more effective and permanent by the addition of a small amount of Paris green and lime. The solution should be thoroughly applied (a scrub brush is excellent for the purpose) to the trunk and larger branches of the tree. If the bark of the trees is especially rough, it should be scraped before the wash is applied; and the soil should be smoothed down about the base of the trunk, so that there will be no cracks for the insects to enter to deposit their eggs. Of course the object of this application is to prevent the laying of the eggs from which the grubs hatch. As an additional precaution it is well to examine the trees during the late summer and early autumn months for eggs and young grubs, which are readily detected, and can be easily destroyed with a knife. In this way one man can go over an orchard of five hundred or more young trees in a day. Professor W. B. Alwood reports excellent results in applying, instead of the wash above described, a paint made of pure white lead and linseed oil, "about the same thickness as for outside coating." It is applied with a brush to the base of the trees in autumn, preventing the injuries of rabbits and other rodents as well as borers. One application lasts a year. A white lead application has been found to injure some cherry trees, however.

The Flat-headed Apple-tree Borer

Chrysobothris femorata

This insect is very different, both in its adult and larval states, from the one just discussed. The adult beetle, instead of being cylindrical in form and brown in color, is flattened and greenish-black. It appears, however, at about the same season as the other, and the life histories of the two species are in general much alike, the principal difference being that the present species

requires less time to develop, and attacks the tree higher up, being found all the way up the trunk, and frequently in the larger branches.

The front end of the larva, which is illustrated in Fig. 24, *a*, is enlarged and flattened while the rest of the body is much narrower, and tapers slightly towards the posterior extremity. It is of a pale yellow color and has no feet. The pupa (*b*) is at first whitish, but becomes

darker as the beetle develops. As noted above, the adult beetle (*d*) is of a shining greenish-black color, and has short, stout legs. It may often be seen basking in the sunshine in summer, on the sides of trees and logs. The eggs of this insect are deposited early in summer in the crevices, and under the scales of the bark, being fastened in place by a glutinous substance. In a few days the larva hatches and bores through the bark to the sapwood, in which

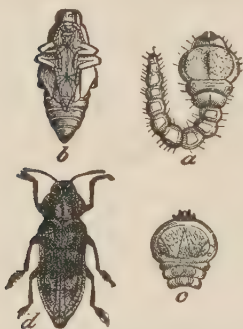


FIG. 24. FLAT-HEADED BORER. *a*, larva; *b*, pupa; *c*, front of larva, lower side; *d*, beetle.

it cuts broad, flat channels, and sometimes completely girdles the tree. As it develops it bores farther into the solid wood, and when fully grown again approaches the surface. When ready to become a pupa it gnaws partially through the bark, and then casts its last larval skin. About a fortnight later the pupa changes to a beetle which gnaws its way through the bark, and thus completes the cycle of development.

Remedies.—The directions given above for the round-headed borer are also applicable to this insect.

INJURING THE BRANCHES

The Oyster-shell Bark Louse

Mytilaspis pomorum

A piece of bark covered with the scales of this insect is represented in Fig. 25. If one of these scales be raised early in spring there will be found beneath it a mass of yellowish or whitish eggs, which hatch about the



FIG. 25. OYSTER-SHELL BARK LOUSE.

middle of May into small lice that appear as mere specks to the naked eye. These move about over the bark a few days, when they fix themselves upon it, inserting their tiny beaks far enough to reach the sap.

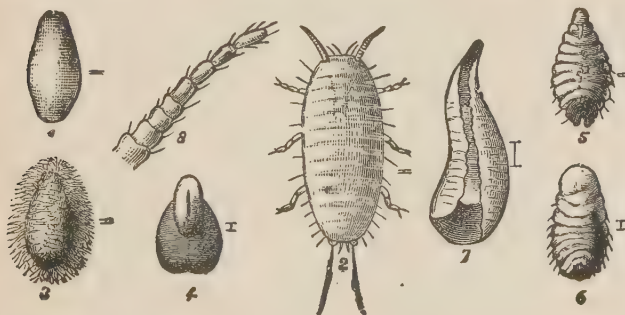


FIG 26. OYSTER-SHELL BARK-LOUSE. 1, egg; 2, young larva; 3, larva forming scale; 4, young scale; 5, 6, lice with scales removed; 7, mature scale. Magnified.

Here they continue to increase in size, and by the end of the season have secreted scaly coverings like those shown in the illustration.



PLATE V. ROOTS OF APPLE SEEDLINGS INJURED BY WOOLLY APHIS. Reduced.

Remedies.—During the winter and early spring as many of the scales should be scraped off the trunk and larger branches as possible. On large trees this may be done by first scraping with some instrument like a hoe, and then thoroughly scrubbing with a scrub brush or broom, dipped in a solution made by adding one part of crude carbolic acid to seven parts of a solution made by dissolving one quart of soft soap, or one-fourth of a pound of hard soap, in two quarts of boiling water. The bark of young trees is so tender that they must be scraped carefully, if at all. A scrub brush is the best thing to use for applying the soap mixture, as the bristles remove many scales which a cloth would slide over. Then in May or June, soon after the young lice have hatched, the trees should be sprayed with kerosene emulsion. The emulsion must be thoroughly mixed, with none of the kerosene floating separately, or it is liable to injure the foliage. When the lice are young they are very readily destroyed by this substance.

The Woolly Aphis

Schizoneura lanigera

There are frequently found on the limbs and trunks of young apple trees, masses of a white, woolly substance, similar to that occurring on the limbs of maple trees infested by the maple-bark louse. If one of these masses be examined there is found beneath it one or more small, yellowish plant lice. This is the insect that has for a long time been popularly known as the woolly aphis, and is sometimes called the apple-tree root louse. There are two forms of the insect, one attacking the roots, the presence of which may be easily detected by the knotty appearance of the infested rootlets (Fig. 27, *a*), and one attacking the limbs and trunk. Like other

aphides, these insects multiply rapidly during the summer months by giving birth to living young. Most of these summer forms are wingless, but occasionally winged ones are found. They all injure the tree by sucking out its sap through their tiny beaks. They are especially liable to infest young trees, or those which are unhealthy. The woolly matter which they secrete as a covering serves to protect them from the damp earth, in their subterranean home on the roots, and probably is a partial protection from enemies above ground. It is

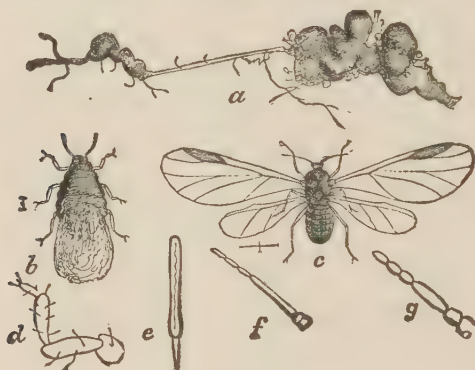


FIG. 27. WOOLLY APHIS. *a*, rootlet showing galls; *b*, wingless aphid; *c*, winged aphid; *d-g*, structural details; *b-g*, magnified.

not a complete protection, however, as they are preyed upon by a small parasitic fly, and by ladybird beetles and their larvæ.

The malformations caused by this insect on seedling apple trees are well represented in Plate V, while Fig. 28 shows healthy roots of similar trees. Trees so injured are unfit for planting.

Remedies.—Where these insects are upon the roots of trees they may be destroyed by applying scalding water, or kerosene emulsion. Refuse tobacco powder

dug in about the roots will also destroy them. Where they are upon parts of the tree above ground, they may be destroyed by spraying with kerosene emulsion. Young



FIG. 28. ROOTS OF HEALTHY APPLE SEEDLINGS. Reduced.

trees from nurseries should always be carefully examined before planting, and if the roots are malformed by this insect the trees should either be burned or disinfected by dipping in kerosene emulsion.

The Buffalo Tree Hopper

Ceresa bubalus

One sometimes finds the twigs of young apple trees exhibiting a peculiar, scarred appearance like that represented at Fig. 29, *e*. These are due to the egg punctures of the above named insect.

The buffalo tree hopper is a small greenish or yellowish insect about one-third of an inch long, which is

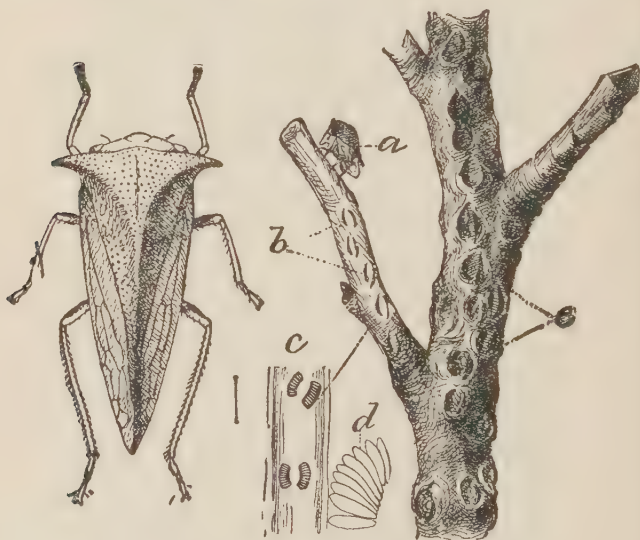


FIG. 29. BUFFALO TREE HOPPER. *a*, adult, magnified and natural size; *b*, fresh punctures; *c*, *d*, eggs; *e*, scars.

generally rather common during the late summer and early autumn months. A fair idea of its form, which has been compared to that of a beechnut, may be obtained from Fig. 29, *a*. Its mouth consists of a sharp beak, which it inserts into the tissues of succulent plants and

sucks their sap. The eggs are laid in the upper part of the young twigs of apple, pear, maple and various other fruit and shade trees, mostly during the late summer and early autumn months. It is believed that a single female may deposit two hundred eggs. "The eggs are placed in small compound groups arranged in two nearly parallel or slightly curved slits extending in the direction of the twig about three-sixteenths of an inch in length, and separated by one-eighth inch or less of bark." In making the second slit the insect cuts the bark obliquely in such a way as to leave a small piece loose; this causes the bark to die and eventually leaves a dead space on the twig. These dead spots are favorite places for wood-boring beetles to oviposit in, so that the injury by the tree hoppers may be followed by more serious damage by borers. The eggs remain dormant until the following spring when they hatch into small, active, greenish hoppers, somewhat like the adults in appearance. These feed upon weeds or other succulent plants, generally developing upon tender annuals in preference to attacking the tougher tissues of woody plants. They become full grown about midsummer. The eggs of the buffalo tree hopper are attacked by at least two minute parasites that serve as important checks upon its increase.

Remedies.—It is always more difficult to prevent the injuries of an insect that feeds upon a large variety of plants, both wild and cultivated, than one which is confined for food to the single crop injured. As a rule it is also more difficult to fight those insects which get their food by sucking than it is those which bite. The buffalo tree hopper combines both of these characteristics, so that from the nature of the case we may expect it to be a difficult insect to overcome by artificial applications. The fact however that the insect develops upon succulent vegetation rather than in the orchard itself,

and the fact that it is most destructive in orchards where weeds and tender herbage are abundant, indicate that clean culture will prove an important method of prevention. Mr. C. L. Marlatt, who has carefully studied the species, writes: "The limiting of the amount of foreign vegetation about and in orchards and nurseries is an excellent precaution, and little damage may be anticipated where the ground between the trees is kept clean and constantly cultivated. The larvæ and pupæ under these conditions will be starved out." The pruning of trees which are badly infested is also recommended.

INJURING THE BUDS AND LEAVES

The Bud Worm

Tmetocera ocellana

There is evidence to show that this insect was introduced to America from Europe early in the present century. It now occurs over a large portion of Canada and the United States, and sometimes is very destructive over wide areas, occasionally becoming the most serious orchard pest of the season. As soon in spring as the buds begin to open, the little caterpillars may commence work upon them, gnawing the miniature leaves and blossoms, but the attack is more likely to begin after the buds about half open. The larvæ then eat out the centers of the buds, where the leaves and flowers are least developed. The caterpillar forms for itself a protecting case by using silken threads to bind together the leaves. As the season advances some of the leaves are killed, become detached at the base, and turn brown; the blossoms also are more or less webbed, so that the smaller branches present an appearance similar to the accompanying illustration. (Fig. 30.)

The life history of this insect may be summarized as follows: The moths appear in the orchard early in summer; during daylight they rest upon the bark of trees or other shelter; at night they fly about and deposit their eggs, one in a place on the underside of the leaves. About ten days later these eggs hatch into small green larvæ, which feed upon the epidermis of the



FIG. 30. WORK OF BUD WORM AMONG OPENING LEAVES.

leaves, each making for itself a silken tube and a thin layer of silk for protection and concealment. In a day or two the green color changes to brown.

"As the larva increases in size and the area over which it feeds becomes larger, the tube is enlarged and lengthened along the midrib, sometimes becoming nearly

one inch in length. The silken web under which the larva feeds covers the entire field of operations, but is so thin near the edges where the larva has last fed as to



FIG. 31. APPLE LEAF SHOWING WORK OF YOUNG
BUD WORM.

be scarcely visible. The excrement of the larva being retained by the web appears as little black pellets scattered here and there over the feeding

ground."* The green portion of only one side of the leaf is eaten, the veins and veinlets being left untouched; these and the green on the opposite side die and turn brown, and thus become conspicuous (Fig. 31).

Late in summer or early in autumn the half-grown caterpillars desert the leaves and crawl upon the twigs, where they form little silken cases, generally near the buds or in creases in the bark. (Fig. 32.) In these they remain throughout the



FIG. 32. Twig showing the position of the winter homes of the larvæ at a, a, and b, natural size.

they emerge to feed upon the opening leaves. They again make tubes, which serve as protective cases. After feeding six or seven weeks they become full-grown; then they form silken cocoons, generally in a rolled leaf or

*M. V. Slingerland.

between two leaves, in which they change to pupæ, to emerge a short time later as moths.

The full-grown larvæ are cinnamon brown in color with the legs, head, and shield behind dead black. They



FIG. 33. BUD WORM. *a*, pupa, front view; *b*, pupa, back view; *c*, larva. Magnified.

are about half an inch long and of the general form shown in Fig. 33, *c*. The moth (Fig. 34) has a general resemblance to the common codling moth. It is dark ashen gray with creamy white blotches on the front wings, which expand a little more than half an inch.



FIG. 34. BUD-WORM MOTH.

Remedies.—These little pests can most successfully be destroyed by spraying with the arsenites early in spring when the buds are opening and the larvæ just beginning the season's work. It is advisable to use the Bordeaux mixture and Paris green combination in order to prevent injury by apple scab or other fungous maladies as well as by insects.

The Apple Aphis

Aphis mali

During spring and early summer, one often finds the leaves and tender twigs of apple trees covered with small green lice or aphides. These are the insects known as the apple aphis. They injure the trees by sucking



FIG. 35. APPLE APHIS. Much magnified.

the sap through their tiny beaks. So far as we now know it, the life history of these insects is as follows: The lice hatch from eggs in spring as soon as the leaf buds begin to expand, and increase with marvelous rapidity, so that almost as fast as the leaves develop there are colonies of the plant lice to occupy them. They continue breeding on apple until

July, when they largely leave the trees and migrate to grasses and other plants. Here, apparently, they continue breeding above ground until autumn, when they return to the apple, and the winged females may be found establishing colonies of the wingless, egg-laying form upon the leaves. The males are apparently developed on grass, along with the winged females. The small, oval eggs are now laid on the twigs and buds, and the cycle for the year is complete.

Remedies.—These lice have various natural enemies that destroy them—especially the ladybird beetles—but it is often necessary to spray infested trees with kerosene emulsion, fish-oil soap, or a strong tobacco decoction to get rid of them. The earlier the application is made the better; the best time is just after the aphides have hatched from the eggs in spring.

The Cankerworm

Anisopteryx pometaria

Apple orchards are occasionally infested in spring by a looping caterpillar, or "measuring worm," that feeds upon the parenchyma of the leaf, leaving the network of veins, so that the foliage looks brown and scorched. These are cankerworms, of which, according to Dr. Riley's observations, we have two distinct species. But both are similar in habits and injuries, and for the present purpose only one will be discussed. This is called the fall cankerworm.

If, during the winter or early spring months, one examines the branches of apple trees in orchards where this insect has been at

work, he will find compact masses of a hundred or more small, cylindrical eggs like that shown at *e*, Fig. 36.

About the time the leaves begin to come out, these eggs hatch into small, looping caterpillars that feed upon

the foliage. They continue feeding and grow-

ing for several weeks, when they become full-grown, and look like *f*, Fig. 36. They are about an inch long, quite slender, and vary from a greenish-yellow to a dark brown color. The cankerworm then either crawls down the tree to the ground, or lets itself down, spider-like, on a silken thread. There it burrows into the soil three or four inches, where it spins a silken cocoon, within which it changes to the pupal or chrysalis state (*g*), remaining in this condition until autumn, when it emerges as a moth.



FIG. 36. CANKERWORM. *a*, male moth; *b*, female moth; *c*, eggs; *f*, larva; *g*, pupa.

The two sexes of these cankerworm moths differ greatly. The male (*a*) has large, well-developed wings, while the female (*b*) is wingless. The latter is of an ashy gray color. When she emerges from the chrysalis state she crawls to the base of the tree, and ascends the trunk some distance. Here the male finds her, and after mating she begins the deposition of eggs. These are placed on the twigs or branches of the tree.

The other cankerworm (*Anisopteryx vernata*) is similar to this in habits, but most of the moths appear in the spring rather than autumn. Hence it is commonly called the spring cankerworm.

Besides apple, these insects feed upon elm, cherry, plum and various other fruit and shade trees.

Remedies.—There are various natural enemies that prey upon these cankerworms; these include both birds and predaceous or parasitic insects. The simplest artificial remedy is to spray the trees, soon after the worms hatch, with Paris green or London purple—a pound to two hundred gallons of water, or stronger if lime is added. Or the ascent of the egg-laying moths may be prevented by applying tar, or printer's ink, or some such substance, about the base of the tree—putting it on a band of paper if there is fear of injuring the tree by applying it directly to the bark. There are also various collars of metal that are manufactured to place around the tree and prevent the moths going up. But spraying is simpler and more effectual than any of these.

The Apple-tree Tent Caterpillar

Clisiocampa americana

One often finds in May or June, on the limbs of apple and wild cherry trees, compact silken nests, or tents, containing a considerable number of handsome caterpillars. These are the insects which have been

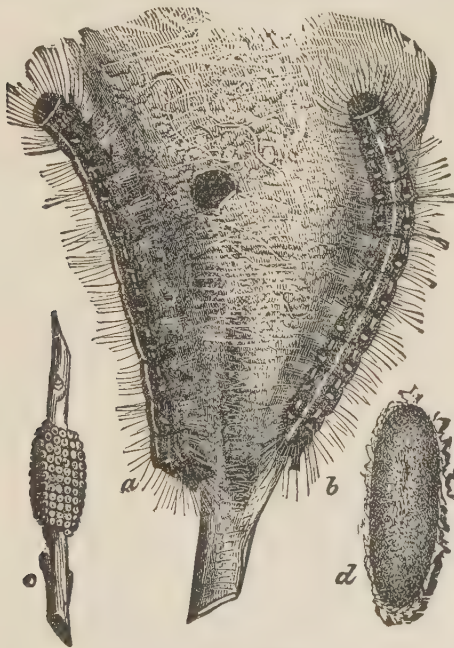


FIG. 37. TENT CATERPILLAR.

a, b, larva; *c*, eggs, with covering removed; *d*, cocoon.

known for many years as tent caterpillars. The eggs are deposited during July, in compact masses of two or three hundred each, upon the twigs, as shown at *c*, Fig. 37. After they are laid the parent moth covers them with a viscid liquid, which dries into a sort of varnish that completely coats them. The insect remains in this

egg state from July until the following spring, when the little caterpillars emerge from the eggs and begin feeding upon the tender foliage of the buds about them. In a few days they begin to make a silken tent, utilizing generally, for this purpose, a fork of the branch. As time goes on the nest is enlarged. The caterpillars retire to the tent at night, and during cold and wet weather, and when not feeding. They have regular times for their meals, leaving and returning to the nest in processions. They become full-grown in about six weeks, being extremely voracious during the latter part of their development. They are then nearly two inches long, with a hairy body ornamented with a distinct white stripe along the middle of the back, on each side of which are numerous short, yellow, longitudinal lines, rather irregularly arranged. The sides are partially covered with paler lines, spotted and streaked with blue, while the lower surface of the body is black. The full-grown caterpillar is represented at *a* and *b*, Fig. 37.

Most of the caterpillars leave the tree where their nest is, as fast as they become full-grown, and crawl about in search of a suitable shelter to pupate in. Having found this—beneath a board, or in the cracks of a fence—they spin an oval, silken cocoon



FIG. 38. MOTH OF TENT CATERPILLAR.

(*d*), yellow when completed, within which they change to the pupal or chrysalis state. In two or three weeks another change takes place, and from the cocoons come forth reddish-brown moths, the females of the size and form represented at Fig. 38. These moths pair and in a short time deposit the clusters of eggs, after which they soon die. Thus there is but one brood each season.

Remedies.—It is usually easy to destroy the nests of this insect, either by cutting and burning the infested

branch, or using a torch made by saturating a piece of cloth, tied to the end of a stick, with kerosene. In either case the operation should be performed early in the morning, before the insects have left the tent, or in the evening after they have returned. Spraying with Paris green is also an effectual remedy. There are certain parasites preying upon this insect that aid greatly in keeping it in check.

The Lesser Apple-leaf Roller

Teras minuta

This is a greenish-yellow, slightly hairy worm, about half an inch long, affecting the young leaves of the terminal twigs, with which the insect forms a protective case. It is especially injurious in nurseries and young orchards.

This species is remarkable in that two of the three broods of moths which appear during the year are of a bright orange color, while those of the third brood are reddish-gray. It is an example of what naturalists call dimorphism.

The eggs are laid in the spring on the unfolding leaves of apple, cranberry, whortleberry and possibly other plants, the larvæ soon hatching to devour the tender foliage, some of which

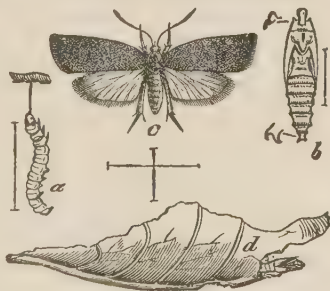


FIG. 39. LESSER LEAF ROLLER.

a, larva; b, pupa; c, moth; d, rolled leaf.

they roll into a protective covering. Here they continue feeding for about a month, when they pupate within the folded leaves, and a week or so later emerge as small, orange-yellow moths. These moths lay eggs for another brood of larvæ, the imagoes from which appear in August,

being also of the same orange color. These in turn lay eggs for a third brood of worms, which develop during September, and emerge during October as glistening reddish-gray moths, which pass the winter in rubbish heaps, fence corners and similar places of concealment, and deposit eggs on the unfolding leaves of the various food plants of the larva the following spring. Thus this remarkable cycle of insect life is completed.

Remedies.—In fruiting orchards that are regularly sprayed with the arsenites to prevent codling moth injury, this insect is not likely to prove troublesome, but in nurseries and young orchards it is frequently quite destructive. Spraying with the arsenites is probably as promising as any general remedy in these cases, though the experience of nurserymen has shown that on young nursery stock the insect may advantageously be destroyed by hiring boys to crush the larvæ within their cases.

The Yellow-necked Apple-tree Caterpillar

Datana ministra

During the latter part of summer the orchardist occasionally finds one or more limbs of his apple trees



FIG. 40. YELLOW-NECKED CATERPILLAR.
a, larva; b, moth; c, eggs; d, magnified egg.

entirely denuded of their foliage by a troop of large, striped caterpillars, like the one shown at Fig. 40, a. These are the progeny of a set of eggs (c, d) laid during

June or July by a large moth (*b*) with a chestnut-brown thorax, and light-brown wings striped with brown of a darker shade. The very young larvæ feed only upon the parenchyma of the leaf, leaving a network of bare veins, but they soon grow large enough to eat veins and all. They are gregarious, feeding together and denuding the limb as they go. When at rest or alarmed they assume the peculiar position shown in the figure. They become full-grown in about six weeks, when they descend to the ground and burrow into the soil three or four inches, where they change to the pupal state. They remain in this condition until the following summer, when they emerge again as moths. Consequently there is but one brood a year.

Remedies.—Birds and various insect enemies prey upon this caterpillar to such an extent that it rarely becomes injurious. When it does, however, it may easily be destroyed by spraying the infested trees with Paris green in water mixture, or by cutting and burning the twigs on which the larvæ are feeding.

The Leaf Crumpler

Phycis indigenella

One often finds during the winter months upon the twigs of various fruit trees, masses of dry, brown leaves that, when pulled apart, are seen to surround a long, tubular, horn-like case. If one of these cases be carefully cut open it will be found to contain a brownish worm or caterpillar, about half an inch long. This insect is the leaf crumpler, and it often becomes one of the most injurious of orchard pests.

The adult insect is a small grayish moth (Fig. 41, *d*) that appears during June or July, and deposits eggs on the various trees that serve as food plants for the larvæ. These include the apple, quince, and possibly the peach, as well as both the wild and cultivated varieties

of the cherry, plum, and crab apple. From these eggs there soon hatch small, brownish worms that construct tubular, silken cases (*a*) within which they remain concealed when not eating. As they grow larger they draw about the openings of their abodes many partially eaten leaves, so that by autumn there is quite a bunch surrounding each case (*b*). At the approach of cold weather the cases are attached to the twigs by means of silken threads, the larvæ frequently gnawing away the tender bark to insure a firm hold; and thus the winter is passed.

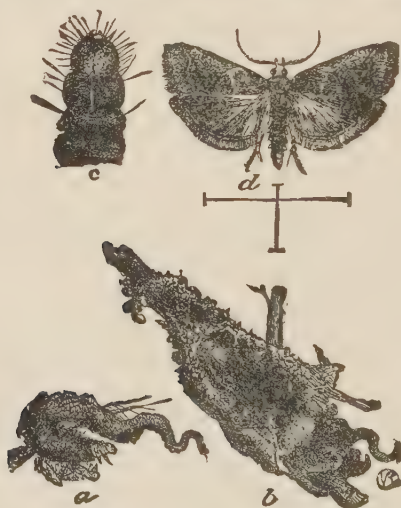


FIG. 41. LEAF CRUMPLER.

a, larval case; *b*, larval case with dead leaves; *c*, front part of larva; *d*, moth, magnified.

As soon in spring as the leaves begin to appear, the larvæ attack them, frequently eating out the flower buds as well. They continue feeding and growing until some time in June, when they become pupæ, pupating within the cases. About a fortnight later the moths emerge, and thus the life cycle is completed.

There are several species of parasites that prey upon the leaf crumpler, which greatly assist in keeping it in check.

Remedies.—In young orchards the larval cases are easily picked off during the winter. They may be burned, or what is probably better, carried to a considerable distance from their food plants and left on the ground, thus allowing the parasites to develop and escape. The insect is also liable to destruction by spraying with Paris green or London purple, and may easily be held in check in this way. Where orchards are sprayed for the codling moth the leaf crumplers present will also largely be destroyed.

The Apple-leaf Skeletonizer

Pempelia hammondi

This is a brownish or greenish larva, one-half inch long, with short, scattered hairs upon its body, which spins a web upon the upper surface of the leaf, and eats the parenchyma, giving the foliage a scorched appearance. It is frequently very destructive to apples, especially to young trees, either in the orchard or nursery.

The life history of this insect may be briefly summarized as follows: The small purplish moths (Fig. 42, *d*), having two light bands upon the front wings, and expanding scarcely half an inch, lay their eggs, probably, on the leaves or tender

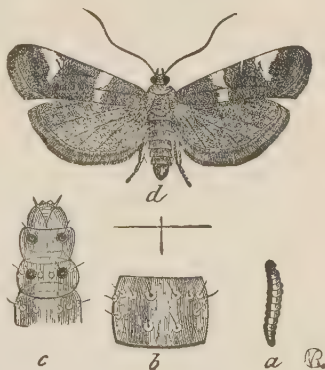


FIG. 42. LEAF SKELETONIZER.

a, larva; *b*, part of back, magnified to show markings; *c*, head and front part of larva, magnified; *d*, moth, magnified.

twigs of the apple, late in spring, or early in summer. The larvæ soon hatch and begin to eat the parenchyma of the leaves, and as they grow older they spin a slight protective silken web on the upper surface of the leaf, beneath which they continue their destructive work. When full-grown (*a*) they vary from an olive or pale green color to brown, are about half an inch long, and have four black shining tubercles on the back, just behind the head. About midsummer these larvæ pupate in slight cocoons, formed usually on the leaf, and two weeks later the moths emerge. Eggs are laid by these for the second brood of larvæ, which form cocoons before winter sets in, and hibernate as pupæ, the moths from them emerging the following spring.

This species is very irregular in its development, it being easy to find larvæ of nearly all ages almost any time during the season. The second brood is usually much more numerous than the first, and consequently the injury is most noticeable in September and October.

Remedies.—Like so many other orchard insects, this pest may be destroyed by spraying with the arsenites—three or four ounces of Paris green, or London purple, to fifty gallons of water.

INJURING THE FRUIT

The Codling Moth or Apple Worm

Carpocapsa pomonella

This is the most generally injurious apple insect, and is probably known wherever the fruit is grown. The small, chocolate moth (Fig. 43, *g, f*) deposits its eggs in spring in the blossom end of the young apple (*b*) before the latter has turned down on its stem. From the egg there hatches a minute worm or caterpillar, which nibbles at the skin of the fruit and eats its way toward the core. Here it continues feeding as the apple

develops, increasing in size, until at the end of three or four weeks it is about three-fourths of an inch long, and appears as represented at *e*. It has now finished its caterpillar growth and, leaving the apple, finds some crevice in the bark where it spins a rather slight silken cocoon, in which it changes to a pupa. It remains in this condition about a fortnight, when it emerges as a moth like the one by which the original egg was laid. Thus the life cycle is completed. There are at least two broods in a season in all but the most northern localities.

Remedy.—

The best remedy for this insect is that of spraying with the arsenites—Paris green or London purple—in spring, soon after the blossoms have fallen off, when the apples are from the size of a pea to that of a hickory nut, and before they have turned downward on their stems. A second application, ten days or two weeks after the first, is generally advisable. The poisons may be used in the proportion of one pound to two hundred and fifty gallons of water, or better, combined with the Bordeaux mixture. The spraying should be done with some kind of spraying pump and nozzle.

Besides destroying the codling moth, spraying at the times indicated will largely prevent the injuries of the various leaf-eating caterpillars and the plum and apple curculios.

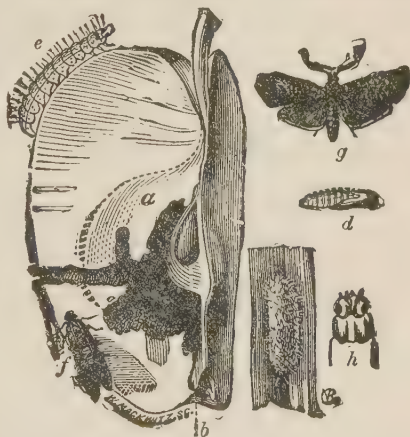


FIG. 43. CODLING MOTH. *a*, injured apple; *b*, place where egg is laid; *c*, larva; *d*, pupa; *e*, cocoon; *g, f*, moth; *h*, head of larva.

The Apple Maggot

Trypeta pomonella

The injury of this insect is at once distinguished from that of the codling moth by the fact that while the latter is largely confined to the region of the core, the apple maggot feeds indiscriminately through the pulp of the fruit, burrowing in every direction. The larvæ themselves are also different, that of the codling moth having six legs, while the apple maggot is footless.

The adult of the apple maggot is a two-winged fly that appears early in summer and deposits eggs in the partially grown apples. These eggs are inserted, one in a place, through the skin of the fruit. In a few days they hatch into maggots, that tunnel the fruit in all directions, becoming full-grown in five or six weeks, when they are whitish or greenish white, and about a quarter of an inch long. They then leave the fruit, and generally go into the soil an inch or less, where they change to the pupal state. They remain in this condition until the following summer, when they emerge as flies again.

Remedies.—This insect is an exceedingly difficult pest to contend with. Fortunately, as yet, it is only seriously injurious in comparatively few States. As a rule, having, however, many exceptions, it seems to be more liable to infest early than late varieties of apples. The only thorough-going remedy is that of destroying infested fruit, especially windfalls. Observations made in Maine by Professor Harvey show that the flies travel little from tree to tree, or orchard to orchard, so that “the checking of the pest is largely an individual matter, to be worked out independently in each orchard.” Unfortunately this insect cannot be destroyed by spraying.



PLATE VI. APPLES INJURED BY CURCULIOS.

The Apple Curculio

Anthonomus quadrigibus

This insect in its adult state is represented magnified at Fig. 44, *c* showing a back view and *b* a side view, while the natural size is represented by the small figure



FIG. 44. APPLE CURCULIO.
Magnified.

a at the left of *b*. This is a beetle related to the plum curculio but having a longer snout. It is dull brown in color and has four tubercles, or humps, on the hinder portion of its back. Before the general cultivation of the improved varieties of apple, it bred in wild crabs and haws. The adult beetles

drill holes in young apples, both for food and the deposition of eggs. The latter are laid at the bottom of the cavity, and soon hatch into grubs or larvæ that feed upon the pulp of the fruit.

They usually penetrate to the core, where they continue feeding four or five weeks. They then become full-grown as larvæ, and appear when magnified like Fig. 45, *b*, being footless, whitish

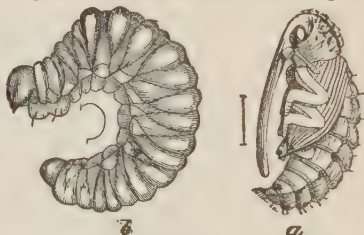


FIG. 45. APPLE CURCULIO. *a*, pupa;
b, larva. Magnified.

grubs. The larva pupates within the cavity of the apple where it has developed, the pupa being represented, magnified, at Fig. 45, *a*, and two or three weeks later it again changes, this time emerging as a perfect beetle which gnaws its way out through the fruit. There is but one brood each year, the insect hibernating in the

beetle state. The fruit attacked by this and other curculios becomes dwarfed, gnarly and ill-shapen, as shown in Plate VI.

Remedies.—The feeding and egg-laying habits of the adult of this insect render it liable to destruction by poisoning. Consequently spraying with the arsenites, as for the codling moth, appears to be a sufficient remedy.

Other Apple Insects

The apple is subject to attack by many insects besides those discussed in the foregoing pages, which, however, include the most injurious pests. The trunk and branches are occasionally infested by the scurfy bark louse (which will be found described on a later page as a pear insect); the leaves are sometimes eaten by various caterpillars beside those mentioned, and the fruit is attacked by the plum curculio as well as by the three species we have discussed. But the treatment recommended will keep in check not only the insects included in our list, but also nearly, if not quite, all of these various other pests.

INSECTS AFFECTING THE PEAR

INJURING THE TRUNK

The Pear-tree Borer

Aegeria pyri

The adult of this insect is a small, clear-winged moth, purplish or bluish black in color, and having three pretty golden-yellow bands across the abdomen. Its eggs are deposited upon the bark of the trunk, and the larvæ feed upon the inner bark or sapwood. The latter are very similar to the grubs of the peach-tree borer, but are considerably smaller. When full-grown they gnaw almost through the outer bark, leaving an extremely thin layer to protect them, and then change to the chrysalis state within the burrow. A short time afterwards the chrysalis wriggles through the burrow to the outer membranous bark, through which it pushes its front end. The fully developed moth then crawls out of the chrysalis, and, after drying its wings, flies away in search of companions and the nectar of flowers upon which it feeds.

Remedies.—This insect is rarely present in injurious numbers, and consequently usually requires little or no attention. The larvæ are said to throw out fine, sawdust-like castings, by which their presence may be detected. When this happens they should be carefully cut out with a sharp knife. Painting the bark with the soft soap and carbolic acid mixture mentioned on Page 64 is also recommended.

INJURING THE BRANCHES

The Scurfy Bark Louse*Chionaspis furfurus*

During the winter months the bark of pear and apple trees is frequently more or less covered by small, flattened, whitish, oval scales, beneath which are numerous minute purple eggs. These are the scales of the female scurfy bark louse, an insect that seems to be more destructive in the Southern and Central States than at the North. It is probably a native of America, having been known to the earliest American entomologists, and is supposed to have fed on wild crab apples before the introduction of improved fruit trees. The scales of the male louse are much narrower than those of the female.

During May or June the eggs beneath these scales hatch into small purplish or reddish-brown lice, that crawl about over the bark for a few days, and finally insert their tiny beaks to suck the sap. Having thus fixed themselves they gradually develop, until by fall the females have become very broad and flat. The eggs are deposited beneath the scale, and remain in this position until the following spring.

Remedies.—The treatment recommended on a previous page (p. 69) for the oyster-shell bark louse, is equally applicable to the present species.

The San José Scale*Aspidiotus perniciosus*

This insect is related to the common oyster-shell bark louse, but can at once be distinguished from the latter by the characteristic round scale—as shown at *b*, Fig. 46.

It infests practically all kinds of deciduous fruit trees and if unmolested is liable to kill them. It was introduced into California from Chile about 1870, since when it has spread over a large portion of the Pacific



FIG. 46. SAN JOSÉ SCALE.

a, pear, moderately infested—natural size; *b*, female scale—enlarged.

slope; and has lately appeared in the Eastern States, where it threatens to do much damage.

Mr. L. O. Howard describes the San José scale as “perfectly round, or at most very slightly elongated or irregular. It is flat, pressed close to the bark, resem-

bles the bark of the twigs in color, and when fully grown is about one-eighth of an inch in diameter. At or near the middle of each scale is a small, round, slightly elongated black point; or this point may sometimes appear yellowish. When occurring upon the bark of the twigs or leaves and in large numbers, the scales lie close to each other, frequently overlapping, and are at such times difficult to distinguish without a magnifying glass.

The general appearance which they present is of a grayish, very slightly roughened scurfy deposit (Fig. 47). The natural rich reddish color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with lime or ashes. When the

scales are crushed by scraping, a yellowish oily liquid will appear, resulting from the crushing of the soft yellow insects beneath the scales, and this will at once indicate to one who is not familiar with their appearance the existence of healthy living scales on the trees."

The young scale lice come out from beneath the female scales, in spring, soon after the unfolding of the leaves. They are minute yellowish creatures, resembling Fig. 48 when highly magnified; they crawl about over the bark a short time, and finally fasten themselves to



FIG. 47. SAN JOSÉ SCALE. Apple branch, with scales *in situ*—natural size; enlarged scales above, at left.

it, generally on the new growth, where they secrete a scale and there develop. Some of them mature into little two-winged creatures, resembling, when magnified, Fig. 50; these are the males; others develop into females, which do not become winged but remain on the bark in a fixed position. In the bodies of these the young are produced, as shown in Fig. 49.

When the San José scale occurs upon older trees, it is most likely to be found on the twigs and smaller



FIG. 48. SAN JOSÉ SCALE. *a*, young larva—greatly enlarged; *b*, antenna of same—still more enlarged.

limbs, but upon young trees it may occur over the whole surface. But it does not confine its attacks to the bark, for the leaves and fruit are often infested; upon the latter there is a very characteristic purplish ring around each scale. These rings are well illustrated in Fig. 46. “Upon the leaves the insects have a tendency to collect

along the midrib, on the upper side of the leaf, in one or more quite regular rows, and also to some extent along the side ribs. The infested leaves turn brown, but do not have a tendency to fall as a result of the damage."

This pest is most likely to be introduced into new localities upon nursery stock imported from infested regions. This is believed to be the way in which it was



FIG. 49. SAN JOSÉ SCALE.

c, adult female containing young—greatly enlarged; *d*, anal fringe of same—still more enlarged.

first brought to the Eastern States. It is also likely to be carried upon fruit sent to market. In a given locality the insects are most likely to be carried from tree to tree and orchard to orchard by the young lice crawling upon insects and birds and then crawling off after they have lit upon other trees. They may also be blown about by the wind.

The young lice are easily destroyed by spraying with kerosene emulsion. But in cases where the insect is first introduced to a new locality, the infested trees should be burned to check the outbreak.

Concerning this, Mr. L. O. Howard, entomologist to the United States Department of Agriculture, says: "The principal mode of spread is by commerce in nursery stock, cuttings and fruit. The time will come in the immedi-



FIG. 59. SAN JOSÉ SCALE. Male adult—greatly enlarged.

ate future when some kind of quarantine regulations will have to be established by States or by large fruit-growing districts. Should this species already have obtained the firm foothold in the East which we suspect, New York, Michigan and other States in which the pomological interests are great, should immediately, by act of legislature, establish quarantine regulations similar to those in force at the present time in the State of California. In the meantime no orchardist should admit a single

young fruit tree, or a single cutting, or a single bud, from a distance into his orchard, without first carefully examining it and satisfying himself absolutely that it does not carry a single specimen of the San José scale. If this plan is adopted by every one interested, and without exception, the rate of spread of the species can be limited to the natural spread by crawling, by winds, and by the aid of other insects and birds.

“We wish particularly to impress upon the minds of fruit growers that as soon as this insect is found to occur in an orchard the most strenuous measures must be taken to stamp it out. No halfway measures will suffice. The individual must remember that not only are his own interests vitally at stake, but those of the entire community in which he resides. Trees badly infested should be instantly burned, as previously stated. The individual may think that he cannot bear the loss, but the loss in consequence of the slightest neglect will be much greater. The fact, too, that there is a community of interests among fruit growers in this matter must not be lost sight of. Fruit growers must be mutually helpful in an emergency like this.”

INJURING THE LEAVES

The Pear-tree Slug

Selandria cerasi

The leaves of pear, cherry, quince and plum trees are frequently attacked during June and July by a greenish-black, slimy slug, that eats the parenchyma off the upper surface. This is the pear or cherry slug. It originates from eggs laid early in June, in the leaf, by a four-winged black fly (shown slightly magnified at Fig. 51). The eggs hatch about two weeks after they are deposited, and the larvæ become full-grown in four or five weeks. They are then nearly half an inch long, and of the form

represented at Fig. 51. They now shed their slimy skins, appearing in a clean yellow suit that is not sticky, and shortly afterwards leave the tree. Having reached the ground they enter the soil two or three inches, and form an oval cavity in the earth, which they line with a glossy secretion. The larval skin is now cast, and the insect becomes a pupa. About a fortnight later it again changes, this time to a four-winged fly, that escapes to continue the propagation of the species. There are two



FIG. 51. PEAR-TREE SLUG.

broods each season in the Northern States, the first brood of larvæ appearing in June and the second in August. The winter is passed in the cocoons.

Remedies.—This pear slug is very easy to destroy, and should be checked as soon after it begins operations as possible. Spraying with the arsenites, or pyrethrum, or hellebore, is a simple and effectual remedy. Or these substances may be dusted on with a powder bellows.

The Pear-leaf Mite

Phytoptus pyri

The leaves of the pear are sometimes noticed in spring to have small reddish spots upon their upper surface. As the season advances these spots become darker colored, and finally appear almost black, the tissues of the leaf where they are being dry and dead. This disease is called the pear-leaf blister and is caused by the pear-leaf mite, an extremely minute creature, related to the red spider found in greenhouses.

Mr. M. V. Slingerland describes in detail the symptoms of the malady as follows: "The disease appears on the pear leaves before they are fully expanded from the bud in spring, in the form of red blister-like spots an eighth of an inch or more in diameter. During this red stage of the disease the spots are more conspicuous on the upper surface of the leaves. About June first the spots gradually change to a green color hardly distinguishable from the unaffected portions of the leaf; this change takes place on the lower side of the leaf first, and the spots may thus be red above and green below. In this green stage, which



FIG. 52. PEAR-LEAF MITE. Magnified.

seems to have been overlooked, the badly diseased leaves present a slightly thicker, corky appearance; otherwise the disease is not readily apparent, especially where not severe. This green stage lasts about a week or ten days, and about June fifteenth the spots may be found changing to a dark brown color, beginning on the lower side of the leaf. The tissue of the diseased parts or spots then presents a dead, dry, brown or black, corky appearance. The spots are also more conspicuous on the lower side, and remain unchanged until the leaves fall in the autumn. They occur either singly, scattered over the surface of the leaves, or often coalesce, forming large blotches which sometimes involve a large portion of the leaf."

The authors of this mischief are extremely minute eight-legged mites which resemble when magnified Fig. 52. Mr. Slingerland who has studied the species most carefully thus describes its life history: "The exceedingly minute oval grayish eggs are laid by the females in



PLATE VII. SEASON STAGE OF THE PEAR-LEAF WINTER.

the spring within the galls that they have formed, and here the young are hatched. How long they remain within the gall of their parent has not been ascertained. But sooner or later they escape through the opening in



FIG. 53. PORTION OF LOWER SIDE OF INFESTED LEAF, SHOWING GALLS CONSIDERABLY MAGNIFIED.

it, and seeking the healthy part of a leaf, or more often crawling to the tenderer leaves of the new growth, they work their way into the tissue, and new galls are thus started. In this manner the galls on a tree are often rapidly multiplied during the summer. The mites live

within the galls, feeding upon the plant cells, until the drying of the leaves in the autumn. They then leave the galls through the openings and migrate to the winter buds at or near the ends of the twigs. Here they work



FIG. 54. SECTION OF LEAF SHOWING GALL IN RED STAGE. *n n*, normal leaf; *o*, opening of gall; *e*, eggs. (After Sorauer.)

their way beneath the two or three outer scales of the buds where they remain during the winter. Fifteen or twenty may often be found under a single bud scale. In this position they are ready for business in the spring as soon as growth begins; and they doubtless do get to work early, for their red galls are already conspicuous before the leaves get unrolled.

“The mites instinctively migrate from the leaves as soon as the latter become dry. Whenever branches were

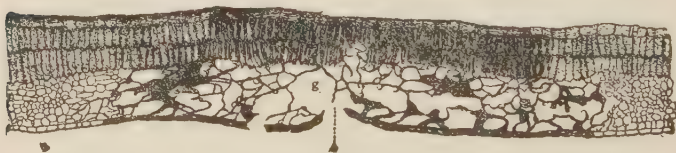


FIG. 55. SECTION OF THE LEAF SHOWING STRUCTURE OF GALLI IN AUTUMN. *g*, gall; *n*, normal leaf; *o*, opening of gall.

brought into the insectary, as soon as the leaves began to dry the mites left them and gathered in great numbers in the buds. It is impossible to accurately estimate the number of mites that may live in the galls on a single leaf. Sections of galls made while in their red stage would seldom cut through more than two or three mites; but sections of the brown galls often showed four or five times as many. Thus on a badly infested leaf there is without doubt at least a thousand of the mites.”

Remedies.—Until recently this pest has been difficult to fight. So long as it remains in the tissues of the leaves it is beyond the reach of insecticides, and as it deserts the leaves before they fall, gathering and burning them in autumn will do little or no good. It has lately been demonstrated by Mr. Slingerland, however, that the pest may be successfully kept in check by a single spraying in winter with kerosene emulsion diluted with five to seven parts of water. The trees should be thoroughly treated.

The Pear-tree Psylla

Psylla pyricola

This is an extremely minute insect, which during recent years has done great damage to pear orchards in several Eastern States. It was apparently introduced into Connecticut early in the present century; since then it has spread west to Ohio, Michigan, and Illinois, south to New York and New Jersey, and probably over much of New England, though here it has been reported as destructive only in Massachusetts and Connecticut.

The adult pear psylla is a small, jumping louse about one-tenth of an inch long, resembling, when magnified, Fig. 56. It has four nearly transparent wings, and is reddish with transverse dark stripes on the abdomen. There are two distinct forms. The summer broods are much lighter in color than the brood which passes through the winter. This difference is so great that the two forms were considered distinct species until the life history was carefully worked out by Mr. M. V. Slingerland.



FIG. 56. PEAR PSYLLA. Magnified.

The dark form passes through the winter in some sheltered situation about the tree, such as beneath loose bark or in the crevices between the branches. In early spring they come forth from their hiding places and deposit their eggs about the buds and on rough bark. These eggs are very small, and of the extraordinary form represented in Fig. 57. When first deposited they are yellowish, but turn dark soon afterwards. The eggs hatch in three or four weeks, the time depending largely on weather conditions. The young psyllas, which during their immature stages are called nymphs, crawl to the stalks of the unfolding leaves, in which they insert their tiny beaks to suck out the sap. They grow rapidly, occasionally molting or shedding their skins to provide for their increase in size, and in the course of a month become mature.

The first summer brood thus developed deposits eggs on the undersides of the leaves. These eggs hatch ten days later, and mature in about three weeks. The insects of the second brood suck the sap from the



FIG. 57. EGG. Magnified. leaves. There are several of these summer broods, the number varying with the locality and length of season. In early autumn the dark, hibernating winter form is developed.

The sap which passes through the bodies of these little creatures is ejected on the foliage, and forms the so-called "honeydew." Where the insects are very numerous this becomes very abundant, falling in showers when the branches are disturbed. After the honeydew has been present for some time a peculiar black fungus develops upon it, and gives the tree a sooty appearance.

Mr. Slingerland makes the following statement concerning the indications of the presence of the pest: "Among the first indications that pear growers, who

suffered from this pest in 1891, had of its presence, was the noticeably lessened vitality of their trees early in the season. Old trees, especially, put forth but little new growth. Where new growth started, in many cases the shoots began to droop and wither in May, as if from a loss of sap. A little later whole trees put on a sickly appearance; the leaves turned yellow and the fruit grew but little. By midsummer nearly all the leaves and half-formed fruit fell from many trees."

Remedies.—This insect can be destroyed by spraying in spring, after the eggs hatch out and before the first brood matures, with kerosene emulsion diluted with twenty-five parts of water. This is a simple and satisfactory remedy; if applied soon after a shower has washed off much of the honeydew, it is more effective.

INJURING THE FRUIT

The Pear Midge

Diplosis pyrivora

This insect appears to have been introduced into America about 1877, being first noticed in Connecticut. It has since spread into a number of neighboring States, and has become in many localities the most destructive enemy of the pear. The adult is a small mosquito-like grayish fly (Fig. 59, c) having a slender body, long legs, and a long ovipositor projecting from the end of the abdomen. These flies appear in the pear orchard in early spring, even before the blossoms open, and continue present about ten days. As soon as the blossoms open sufficiently for the insect to insert its ovipositor, the eggs—often nearly a dozen in number—are deposited inside the blossom envelopes. Three or four days later the eggs hatch into little maggots which enter the open ovary of the embryo fruit, where they feed upon the growing tissues, gnawing and rasping it in such a

manner as to destroy the core and seeds, and cause the fruits to become dwarfed and deformed. Such pears are ill-shapen in outer appearance, as shown in the series represented in Fig. 58. The midge maggots at first are whitish in color, but they soon become orange or reddish. They become full-grown early in summer; they are then "about one-sixth of an inch in length, pointed towards each extremity, yellow in color, with a brown, horny breastbone on the underside just behind the head.



FIG. 58. PEAR MIDGE INJURY. *a*, uninjured young pear; *b*, infested pear cut open to show midge larvæ; *c*, *d*, *e*, *f*, outlines of infested fruits.

The segments of the body are well marked, and when removed from the infested fruit they move about quite rapidly, bending themselves quite double by drawing the tail forward until it touches the head, and then jerking or springing upward and outward several inches at a time. When they are full-grown they remain in the fruit until there comes a rain, which causes a rapid decay and a cracking open of the infested fruit. Through the openings so made they emerge and drop to the ground."* They then enter the soil an inch or two

*J. B. Smith.

where somewhat later they make oval cocoons of silk mixed with particles of earth or sand; in these cocoons they remain apparently unchanged until the following spring when they become pupæ and shortly afterwards again change to adult flies.

These midges appear to have decided preferences among varieties of pears, the Lawrence being the favorite.

Remedies.—The only stage at which this insect is liable to injury without detriment to the trees is when the larvæ are in the ground. Professor J. B. Smith of

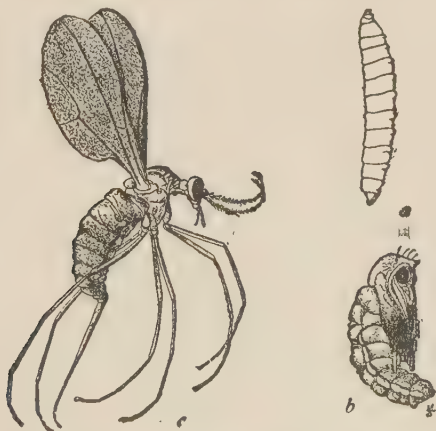


FIG. 59 PEAR MIDGE. *a*, larva; *b*, pupa; *c*, parent fly. Magnified.

New Jersey has found that they then can be destroyed to advantage by the application of kainit, applied about the middle of June to the ground beneath the trees, at the rate of 1000 pounds to the acre. This is dissolved by the soil moisture and causes the death of the naked midge larvæ. In case an orchard is generally infested Professor Smith recommends the following practice: "Cultivate as usual, or if the orchard is in grass or clover, plow under after June 15th, as soon as may be. Top-dress with kainit, 1,000 pounds to the acre, to

benefit trees as well as to kill insects. As soon as proper, say early in August, sow crimson clover. This will use up the potash not required by the fruit trees, and will store nitrogen, as well as occupy the ground. Early in the following spring turn this sod under as deeply as may be proper. It should be done before the pear buds are developed, in order to head off and destroy any midges then in the pupal state near the surface of the soil."

The Codling Moth and Plum Curculio

In most regions these pests are the worst insect enemies of the fruit of the pear. To the first is due the "worminess" that spoils so large a portion of the crop, and to the second a large part of the gnarly, knotty fruit that is so often seen. Spraying with Paris green is fortunately an effectual preventive of the injuries of both.

Other Pear Insects

The trunk of the pear tree is subject to attack from both the round-headed and flat-headed apple-tree borers. The remedies mentioned as applicable to the apple are equally so to the pear. The branches are sometimes infested by the oyster-shell bark louse, the pear-tree bark louse (*Lecanium pyri*), as well as the pear-blight beetle (*Xyleborus pyri*), and the fruit-bark beetle (*Scolytus rugulosus*). The leaves are also liable to attack from a great variety of caterpillars, which, however, are seldom seriously injurious.

INSECTS AFFECTING THE PLUM

INJURING THE BARK

The American Plum-tree Borer

Euzophera semifuneralis

Plum trees are occasionally attacked by small, dusky caterpillar-like borers, having reddish heads and being sparsely furnished with long hairs. They are most likely to infest the upper portion of the trunk and the bases of the larger branches. It is the larva of a small moth that appears in May and June, and probably deposits its eggs on the bark. The eggs hatch into larvæ that feed in the tissues of the inner bark, sometimes causing the death of the trees. The insect remains in the larval condition through the winter and pupates in May, to emerge a little later as a moth.

It is probable that applying to the trunk and larger limbs the washes recommended for the apple borer will prevent the injuries of this pest.

The plum is also subject to attack by the peach-tree borer and another closely related species (*Sannina pictipes*) that breeds in wild cherry. The soap washes are believed to prevent their depredations also. When the borers are present they may be cut out with a sharp knife.

INJURING THE LEAVES

The Plum Scale

Lecanium sp.

In several widely separated localities attention has been called to a large scale insect affecting plums, which in some regions has become quite destructive. The appearance of the insect on the branches is well shown in the lower part of Fig. 60. Beneath each of these scales

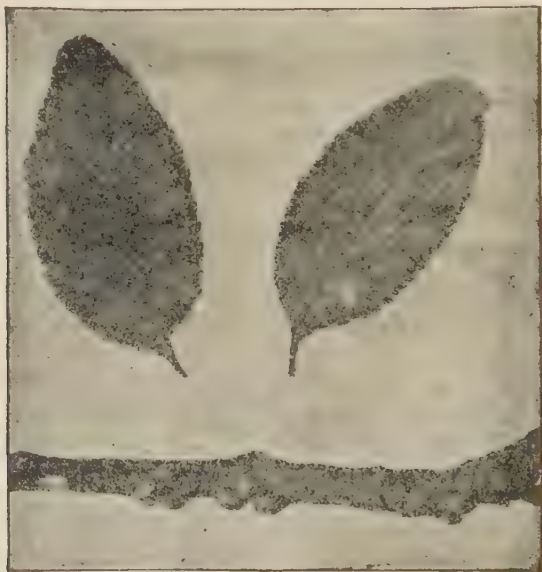


FIG. 60. Plum branch showing young scales in hibernation near large mother shells; leaves with young scales along veins, as they appear in summer.

there are deposited early in summer a large number of small white eggs—each female being said to lay a thousand or more eggs. A month later these eggs hatch into tiny creatures that wander to the leaves, where they in-

sert their beaks and suck out the vegetable juices; some of these young lice are represented in the upper part of Fig. 60. They produce a great amount of the so-called "honeydew" while on the leaves. Early in autumn they migrate to the undersides of the twigs, where they pass the winter.

Remedies.—"The way to combat this pest is to spray the infested trees several times, at least twice in winter or before April, first with kerosene emulsion (standard formula) diluted with four parts of water. Always bear in mind that each little scale must be hit with the liquid. Do not let the pest get started in force in April; if it does you cannot fight it effectively until about July first. Then the young are hatching, and while they are wandering about on the branches for a few days, they can be successfully destroyed by the emulsion diluted even six or eight times. If these young scales get established on the leaves in July, they will be beyond control with a spray until November. But the moment the leaves fall, begin the work of destruction on the tender hibernating scales then exposed on the bark. Thoroughness must be the watchword if this new and most serious enemy is to be checked."—[Slingerland.]

The Plum-tree Aphis

Aphis prunifolii

The leaves of plum trees are frequently crowded in spring by small, dark-colored, soft-bodied insects that suck out the sap, and give the terminal portion of the twigs a malformed appearance. These are aphides or plant lice. Two or three species are known to infest the plum, one of which has been shown by Dr. C. V. Riley to migrate during summer to the hop plant. The life histories of the others are not very well known. In a general way they are similar to the apple aphis described on a previous page.

Remedies.—Spraying with kerosene emulsion is the most effective remedy for this insect. The application should be made with a force pump and spray nozzle, and as soon after the insects are noticed as possible.

Plum-leaf Caterpillars

There are several kinds of caterpillars that occasionally attack the plum, but they rarely occur in sufficient numbers to do serious injury. Of these we may mention the plum catocala (*Catocala ultronea*), the polyphemus moth (*Teia polyphemus*), the horned spanworm (*Nematocampa filamentaria*), the plum sphinx (*Sphinx drupiferarum*), the gray dagger moth (*Apatela occidentalis*), and the disippus butterfly (*Limenitis disippus*). These insects are all open to destruction by spraying with the arsenites, and are not likely to become injurious in orchards regularly sprayed for the plum curculio.

INJURING THE FRUIT

The Plum Curculio

Conotrachelus nenuphar

This insect, the worst foe of the plum grower, is the cause of the "worminess" and premature dropping of the fruit with which so many orchardists are familiar. Besides plums, it breeds in peaches, nectarines, apricots, cherries, pears and apples.

The adult insect (Fig. 61, *c*) appears in spring about the time of blossoming, and feeds upon the foliage and flowers until the fruit is well "set." It then attacks the young plums, gnawing at them to satisfy its hunger, and cutting crescent-shaped marks in the skin to deposit its eggs (*d*). In a short time these eggs hatch into little grubs that feed upon the pulp of the fruit, gradually working toward the pit. In a few weeks the

become full-grown (appearing when magnified like *a*), by which time the infested plums have generally fallen to the ground. The larvæ then leave the fruit, and entering the soil a short distance change to pupæ (*b*). A few weeks later they again change, and come forth as perfect beetles. But some of them enter the ground so late that they hibernate as pupæ, emerging the following summer. There is but one brood each season. A single female is able to deposit one hundred and fifty to two hundred eggs, ten frequently being laid in a single day. Certain parasites prey upon this insect, and are occasionally sufficiently numerous to prevent its injuries in certain localities.

Remedies. — Entomologists have been divided in opinion as to whether this insect can

successfully be destroyed by spraying with the arsenites, but the evidence in hand indicates that under usual conditions this is the best way to fight the pest, especially in large orchards. It has been conclusively proven that a majority of the curculios in a sprayed orchard will be killed by the poison, but the effect is not immediate. Consequently there may be opportunity for a certain amount of oviposition before the curculios die. When a heavy crop of fruit sets, it is desirable that a portion of it should be thinned, so that the injury of a small percentage of the plums is no disadvantage. It is advisable to use the Bordeaux-arsenite combination, thus avoiding the injury which sometimes results when Paris green or London purple alone is applied, and also preventing damage by fungous diseases—such as the leaf spot and

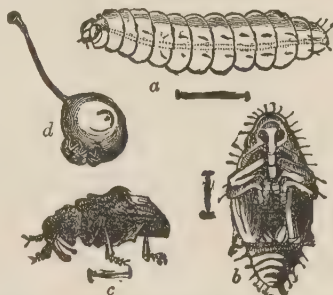


FIG. 61. PLUM CURCULIO. *a*, larva; *b*, pupa; *c*, beetle—magnified; *d*, plum showing crescent mark.

plum rot. Three or four sprayings are advisable, the first just before the blossoms open, the second soon after the blossoms have fallen, the third about ten days after the second and the fourth about fifteen days after the third. If Paris green alone is used (four ounces to fifty gallons water), lime should be added, as some varieties of plums are very easily injured by the arsenites.

The other method of fighting this insect is that of "jarring." This takes advantage of the fact that when a limb on which the curculio is at work is suddenly jarred, the insect drops to the ground. A large sheet is placed beneath the tree, and the latter is jarred by striking the trunk and larger branches with a padded mallet. The curculios fall upon the sheet, and are then collected and destroyed. Instead of a sheet, most commercial growers use a sort of inverted umbrella mounted on wheels, which is run beneath the tree. It has sloping sides down which the insects roll into a receptacle in the center, where they are caught. There are many patterns of these catchers in use in different sections of the country. The insects are most easily caught in the morning when the atmosphere is cool. In case only a small crop of fruit sets and curculios are abundant, jarring is more certain to save it than spraying.

The Plum Gouger

Coccotorus prunicida

The plum gouger is most injurious in the region west of the Mississippi river, being rarely or never found in the Eastern States. But in Iowa, and probably also in adjacent States, it frequently is more destructive than the plum curculio, from which it differs considerably in history and habits. The adult gouger is a small snout beetle, about the same size as the curculio, but with a smooth back, and of a yellowish or brownish color. It

appears about blossoming time, and soon after the fruit sets begins operations upon it. Instead of cutting a crescent-shaped mark in which to lay its egg, it gnaws out a little cavity beneath the skin, in which the egg is deposited. A few days later the larva hatches, and burrows through the pulp to the pit, gnawing through the soft shell to the "meaty" portion inside. Here it continues to develop, feeding upon the contents of the pit, rather than the pulp surrounding it. After several weeks it becomes full-grown; it then gnaws a hole through the hardening wall of the pit, so it can escape after completing its transformations, and changes to the pupal state inside. A short time afterwards it again changes, this time to the adult, and the beetle gnaws its way to the outer world, hibernating in this condition. It is single-brooded.

Like the plum curculio, the adult plum gouger gnaws pits in the fruit for food. It also has various natural enemies that help to keep it in check.

Remedies.—One would suppose, from the feeding habits of the plum gouger, that the adults were liable to destruction by spraying with the arsenites, but experiments made in Iowa by Prof. C. P. Gillette do not confirm this opinion. However, the matter seems not to have been thoroughly tested on a large, commercial scale. If spraying is ineffective, recourse must be had to the jarring method.



FIG. 62. PLUM GOUGER.
a, punctures on fruit.

Other Plum Insects

The base of the trunk of the plum tree is occasionally attacked by the peach-tree borer; and the upper portion of the trunk is sometimes infested with the flat-headed apple-tree borer and the fruit-bark beetle. The leaves are attacked by a large proportion of the caterpillars that feed on the foliage of the apple, as well as the pear or cherry slug, the grapevine flea beetle, and a number of other insects. But spraying is a safe specific for nearly or quite all of these defoliators.

INSECTS AFFECTING THE PEACH

INJURING THE ROOT

The Peach-tree Borer

Sannina exitiosa

The peach-tree borer is a soft, whitish caterpillar, with a reddish-brown head and sixteen legs. It hatches from eggs laid during the summer months by a handsome, day-flying moth, upon the bark of the trunk, at or near the soil surface. After hatching, the young larvæ burrow through to the inner bark and sapwood of the larger roots, upon which they feed, causing a gummy



FIG. 63. PEACH-BORER MOTH. *a*, male; *b*, female.

exudation that betrays their presence. They continue feeding in this way for nearly a year, being interrupted of course during the winter months, when they become full-grown as larvæ. They then usually approach the top of the ground within an inch or two of the soil surface, and construct cocoons of the gummy exudation, their castings, and silk. Within these cocoons they change to the pupal state, and three or four weeks later again change to moths. The two sexes of the moths

are represented, natural size, in Fig. 63, *a* representing the male, and *b* the female. These moths are present more or less all summer; although there is but one generation a year, the larvæ reach maturity at such different times that they keep up a nearly constant supply of the imagos. On this account one can find larvæ of various sizes in the roots at almost any time. This insect also occasionally infests the plum.

Remedies.—One of the most generally practiced methods of preventing the injuries of this insect is that of cutting out the larvæ in the fall or spring, or both. To do this the earth is removed from about the base of the tree, and wherever the gummy exudation indicates that a borer is at work, a sharp knife or wire is inserted to kill it. It is often necessary to open the larval channels for some distance before the depredator is found. Instead of digging the larvæ out, some growers destroy them by applying scalding hot water. With this method the earth is removed as before, and the gummy exudations scraped away before the water is applied.

Some growers prevent the deposition of eggs by mounding the soil up about the base of the trunk a foot or more, late in spring, removing it in September. The chief objection to this method appears to be that it is liable to make the bark too tender to stand the winter. Others protect the base of the trunk by fastening paper or straw around it, so as to cover the bark. In Virginia good results have been reported from painting the trunks with paint made from pure white lead and linseed oil, about the thickness for ordinary use. This is applied in autumn and lasts a year, the earth about the base being scraped away in order to apply it below the usual soil surface. A similar mixture, however, has been reported to injure cherry trees, and I would advise that it be used cautiously, if at all.

The Black Peach Aphis

Aphis persicæ-niger

This is a shining black aphis that occurs in great numbers upon the roots, twigs and leaves of the peach in the Atlantic States. The root-infesting specimens seem to be especially injurious, causing an enfeebled condition of the tree that has sometimes been mistaken for the disease known as the "yellows." These insects reproduce viviparously, or by giving birth to living young, and consequently, like other aphides, they are able to multiply with remarkable rapidity. There are two forms, one wingless and the other winged, both having shining black bodies, and sucking out the sap of the tree through their tiny beaks.

Remedies.—The best results seem to have been attained in fighting the underground form of this insect by digging into the soil about the roots refuse tobacco, either in the form of powder or stems. Kainit is also said by New Jersey peach growers to serve a similar purpose. The aerial specimens are open to destruction by spraying with kerosene emulsion.

INJURING THE TRUNK AND BRANCHES

The Fruit=bark Beetle

Scolytus rugulosus

This is a small beetle which attacks apple, pear, quince, cherry, plum and peach trees, by boring small holes through the outer bark and then forming burrows in the inner bark. It seems to prefer the stone fruits, and more often seriously injures them than the apples and pears. Many entomologists believe that these beetles attack only diseased trees, but the observations of Professor Forbes, who has studied the species most carefully, indicate that "while these insects clearly prefer weakened

trees, and will continue to breed in them to some extent even after they are nearly or quite dead, they nevertheless may attack such as are really healthy and in which the flow of sap is temporarily restrained by transplanting or a relatively unthrifty growth."

I am indebted to Professor Forbes's writings for the following account of the injuries and life history of this fruit-bark beetle. The upper portion of the trunk and bases of the larger limbs are most commonly attacked, but the injury often extends to the branches and smaller twigs. "The first conspicuous evidence of injury to the

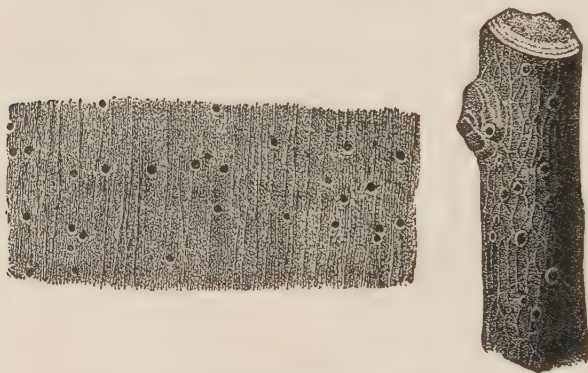


FIG. 64. TWIG AND BARK SHOWING PUNCTURES.

twigs is a withering of the leaves and a shriveling of the bark similar to that caused by blight; but if the trunks and larger branches be attacked, damage to the bark may go on for some time without manifest effect upon the general appearance of the tree." By closely examining the bark where the insects are at work one will see that it is blackened, and will always find "minute round punctures half or two-thirds the diameter of the head of a common pin. If the bark is cut away these openings are seen to penetrate it, commonly, to the wood, the channels usually running vertically inward; and if the tree

be badly infested the under surface of the bark will be almost completely eaten out and marked by a network of channels of about the same diameter as the small holes already mentioned." Most of these grooves run lengthwise of the stem, and furrow both the bark and the surface of the wood (Fig. 65). "More critical examination will show here and there a broader burrow; and from this central larger channel a great number of much smaller ones will pass out to the right and left as closely as they can be placed, increasing in size as they go, and presently changing direction, so that those at first running crosswise of the stem become longitudinal." At the end of these smaller channels one may often find a small footless grub, the larva of the beetle.

These peculiar burrows are made in the manner thus described: "The

female beetle, resorting to the tree, burrows into the bark directly inward, and then, turning lengthwise of the bark, digs a channel from half an inch to an inch and a quarter long,—the larger burrow described above, called the breeding chamber,—laying eggs to the right and left as she makes her way. As these eggs hatch, the young larvæ, very small at first, eat outward in all direc-

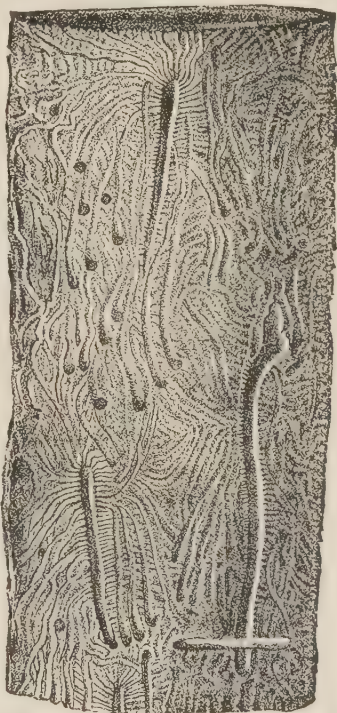


FIG. 65. CHANNELS OF FRUIT-BARK BEETLES.

tions, forming the closely placed radiating channels already described, enlarging the burrow of course as they increase in size themselves; and finally, when they have reached their growth, each sinks itself into the sapwood to a depth scarcely greater than its own thickness, stopping the channel behind it with a little mass of wood fiber, and there it changes to the pupal stage. This terminal cell is consequently called the pupal chamber. In this little harborage the adult beetle appears and eats its way out through an opening similar to that by which the mother entered in the beginning."

The fruit-bark beetle is a small black insect, with the tips of the legs and wing covers russet-red. The larva is whitish with a brown head. Both stages measure about one-tenth of an inch in length.

Remedies.—The fact that this insect attacks unthrifty and diseased trees indicates the advisability of keeping trees thrifty and healthy by careful cultivation and fertilization. The insect passes the winter in the larval state within the burrows, so that burning infested trunks and branches at that season will destroy the pests within. It is also probable that spraying with some adhesive poisonous mixture—such as the Bordeaux-arsenite combination—when the beetles are penetrating the bark to deposit eggs, would kill them. In Indiana trees sprayed in spring with this combination escaped injury.

INJURING THE LEAVES

The Peach Aphis

Myzus persicæ

This insect is much like the black peach aphis, with which, in fact, it has frequently been confused, but it appears to be distributed over a much wider area, being found in nearly all portions of the United States where peaches are grown. Like other aphides, it damages the

tree by sucking out the sap through the leaves or tender twigs. It is a soft, blackish little creature that, during the spring and summer months, reproduces by giving birth to living young. The species winters over in tiny, black eggs, laid in September or October, upon the twigs about the buds.

Remedies.—Spraying with kerosene emulsion is the best method of destroying these little pests.

INJURING THE FRUIT

The Plum Curculio

Conotrachelus nenuphar

This insect, whose life history has already been treated of on page 116, breeds in peaches, as well as in plums, cherries, apples and other fruits. It is especially liable to injure peaches when there is a failure of the apple crop. It is more difficult to prevent its injuries on this crop than on the apple or plum, because ordinarily it is impracticable to jar peach trees, and their foliage is so easily injured by the arsenites that spraying must be done with great caution, if at all. Probably the safest way is to spray with the Bordeaux-arsenite mixture. One or two sprayings, soon after the fruit sets, will probably help greatly in preventing curculio injury.

Other Peach Insects

The trunk of the peach is sometimes infested by the flat-headed borers of the apple and cherry, though not often. The branches are subject to the attacks of the peach-tree bark louse (*Lecanium persicæ*) and the New York weevil (*Ithycerus noveboracensis*); while the leaves are more or less affected by a great variety of caterpillars which, however, rarely do any serious injury.

INSECTS AFFECTING THE CHERRY

INJURING THE TRUNK

The Flat-headed Cherry-tree Borer

Dicerca divaricata

This insect is closely related to the flat-headed apple-tree borer, to which it is similar in life history and habits. The adult, a handsome, brassy- or copper-colored beetle, about four-fifths of an inch long, deposits eggs during the summer on the trunk of the wild and cultivated cherry. These eggs hatch into larvæ that bore through the bark to the sapwood, upon which they live. They gradually grow larger until, when full grown, they pupate, and shortly afterwards again change to the beetle state.

Remedies.—Fortunately this borer is rarely seriously injurious. Should it become so, the treatment recommended for the flat-headed apple-tree borer would be also applicable in this case.

INJURING THE LEAVES

The Cherry Aphis

Myzus cerasi

The twigs and under surface of the leaves of the cherry are frequently thickly infested during May and June by small, shining plant lice that suck out the sap and deform the leaves. This insect is the cherry aphis. It winters over on the twigs in the egg state. Early in spring the eggs hatch into young aphides that crawl

upon the bursting buds, inserting their tiny sap-sucking beaks into the tissues of the unfolding leaves. In a week or ten days they become full-grown, and begin giving birth to young lice, which also soon develop, and repeat the process. In this way they increase with marvelous rapidity. Most of these early spring forms are wingless, but during June great numbers of winged lice appear, and late in June or early in July they leave the cherry, migrating to some other plant, although we do not yet know what that other plant is. Here they continue developing throughout the summer, and in autumn a winged brood again appears and migrates back to the cherry. These migrants give birth to young that develop into egg-laying females, which deposit small, oval, shining black eggs upon the twigs about the buds.

Remedies.—Lady beetles and certain predaceous and parasitic flies prey upon these little pests in great numbers, and often aid materially in checking their injuries. The best artificial remedy is that of spraying with kerosene emulsion, early in the season.

The May Beetle

Lachnosterna fusca

The leaves of cherry and other fruit trees are sometimes eaten early in summer by the common May beetle or June bug. This insect is the parent of the mischievous white grub, that is so frequently destructive in meadows and pastures. The beetles feed upon the foliage at night, and sometimes appear in sufficient numbers to do much damage before their presence is discovered.

Remedies.—Spraying the infested trees with the arsenites, Paris green or London purple, is the most promising method of preventing their injuries.

The Cherry-tree Leaf Roller

Cacæcia cerasivorana

One occasionally finds the leaves of a cherry twig fastened together in a large, compact nest, inhabited by numerous yellow caterpillars, that feed upon the inclosed leaves. This is the cherry-tree leaf roller. The adult



FIG. 66. CHERRY TREE ON WHICH OPENING BUDS WERE DESTROYED BY LEAF ROLLERS.

is a small brown moth which deposits a large number of eggs upon the twig. The caterpillars on hatching fasten the leaves together and develop within the tent thus formed. They become full-grown about midsummer,



PLATE VIII. APPLE TWIG SHOWING WORK OF LEAF ROLLERS.
b, young apples gnawed by larvæ.

and pupate within the nest. In a week or so they are ready to change again, and the pupæ work their way out until they are nearly free from the nest, remaining attached by the hinder portions of their bodies. The skin then splits along the back and the moths come out.

Remedies.—These nests are so conspicuous that it is a simple matter to cut and burn the infested twigs, thus ending the career of the pests.

The Fruit-tree Leaf Roller

Cocæcia argyrospila

This is a widely distributed insect that appears to be most destructive in the West. In general its life history is similar to that of the species last described. The way in which the larvæ, which feed on many kinds of trees, roll the leaves is well shown in Plate VIII. The amount of injury the insect sometimes does is shown by Fig. 66, which represents a cherry tree defoliated by the pest. Spraying with the arsenites is the best remedy.

The Pear-tree Slug

Erio campæ cerasi

This insect is probably as destructive to the cherry as to the pear, under which we have already discussed it. Its life history on the two fruits is similar, and the remedies are the same in both cases.

INJURING THE FRUIT

The Plum Curculio

Conotrachelus nenuphar

This insect, which has already been discussed under the plum (p. 117), is also exceedingly injurious to cherries. The latter, however, usually do not fall off when

infested by the curculio larvæ, but remain on the tree until the fruit ripens. The remedial measures suggested in connection with the plum are equally applicable to this fruit.

Other Cherry Insects

There are a large number of caterpillars that feed upon the leaves of cherries, but they rarely do noticeable injury, and spraying with the arsenites will keep nearly if not quite all of them in check.



1



2



3



4



5



6



7

PLATE IX. A GROUP OF LEAF HOPPERS. Magnified.

PART II

INSECTS AFFECTING SMALL FRUITS

INSECTS AFFECTING THE STRAWBERRY

INJURING THE ROOT

The Strawberry-root Worms

Paria aterrima, *Graphops pubescens*, and *Scelodonta nebulosus*

In the larval stage the three species of beetles named above feed upon the fibrous roots of the strawberry, often doing a great deal of damage. They are quite similar in life history and habits, all depositing eggs about the base of the plant, that hatch into small whitish grubs. The grubs feed upon the strawberry roots, increasing gradually in size. When fully grown they are small six-legged grubs, with brown heads. They pupate in earthen cells in the soil, and soon after emerge as small beetles that feed upon the foliage of the strawberry, often doing a noticeable damage. The injury of these insects in the larval state is frequently mistaken for that of the strawberry-crown borer—an entirely different species.

Remedies.—These little insects are difficult to deal with on account of the underground habits of the larvæ, and the different times of development of the adults. Professor Forbes recommends spraying or dusting the foliage with Paris green or London purple occasionally, after the fruit is harvested, to destroy the leaf-eating beetles. Badly infested fields should be plowed up soon after the crop is gathered. Old unused strawberry fields should not be left as breeding grounds for these and other strawberry pests.

The Strawberry-crown Miner

Anarsia lineatella (?)

This is a small, reddish caterpillar that bores the strawberry crown, making irregular channels through it in all directions. It becomes fully grown early in summer, and changes to the chrysalis state, to emerge two or three weeks later as a small, dark gray moth. Eggs are deposited by this moth upon the crown of the plant, and soon hatch into minute larvæ that bore the crown again, becoming partially grown before winter, and hibernating within their burrows. This is the life history of the species in Canada; probably farther south there may be two broods a year.

Remedies.—No successful remedy for this insect is known. Badly infested fields would probably have to be plowed up, and this should be done preferably in the fall or early spring.

The Strawberry-crown Borer

Tyloderma fragariæ

This insect has been known for many years as one of the most destructive enemies of the strawberry in the great small-fruit fields of the Mississippi Valley. The larva (Fig. 67, *a*,) is a whitish, footless, yellow-headed grub about one-fifth of an inch long, that lives in the crowns of strawberry plants, frequently hollowing them out so much that the vines are weakened or destroyed. The adult insect is a small, dark-colored snout beetle about a fifth of an inch long, and of the form represented at Fig. 67, *b*, *c*. It is unable to fly, because of the rudimentary condition of its membranous wings. According to Professor Forbes, "the eggs are laid on the crown in spring, being pushed down among the bases

of the leaves. The larvæ penetrate the crown soon after hatching, and excavate the interior all summer, until they get their growth. A single larva does not wholly destroy a plant, as it matures about the time a quarter or a third of the substance of the crown is devoured. Frequently two or three or more beetles will attack a single stool, and they then leave behind them only a hollow shell to which the roots are attached. Still in its subterranean cavity the worm transforms to a pupa, and in the same safe retreat

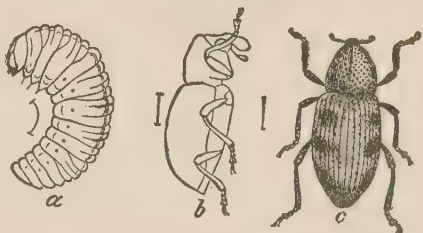


FIG. 67. STRAWBERRY-CROWN BORER.

a, larva; *b*, beetle, side view; *c*, beetle, back view.

effects also the final change to the mature beetle, this last transformation occurring all the way along from August to October, during a period of about two months. The beetles all escape from the crowns in autumn, but are not known to lay any eggs until the following year. They pass the winter as adults in the fields infested by them as larvæ. It feeds while a mature insect upon the tissues of the plant."

Remedies.—This insect is especially liable to injure old strawberry fields, or those which are replanted to this fruit without some other crop intervening. On account of the inability of the beetle to fly, it is not likely to pass from one plantation to another to deposit eggs, and the isolation of new plantations from old ones is consequently to be desired. If the plants for the new field must be taken from an infested patch, they should be dug up as early as possible, to guard against transporting eggs or larvæ with them. It is probable that spraying the fields with the arsenites late in summer will lead to the poisoning of many of the beetles, and that

burning the fields after picking will prove beneficial. In case infested patches are to be plowed under, this should be done late in June or early in July, to destroy the half-grown larvæ then present in the crowns.

INJURING THE LEAVES

The Strawberry-leaf Roller

Phoxopterus comptana

This is a small, brownish caterpillar that folds the leaflets of the strawberry by bringing the upper surfaces together and fastening them by silken cords (Fig. 68),



FIG. 68. STRAWBERRY LEAF FOLDED BY LEAF ROLLER.

and feeds upon their substance till they look brown and scorched. It is sometimes exceedingly destructive, and has been considered by some entomologists the most injurious of the insect enemies of the strawberry. It prob-

ably occurs in nearly all the Northern States; and is also found in Europe, where, however, it does not prove troublesome. It hatches from eggs laid in spring upon the strawberry plants by a small, reddish-brown moth, which is accurately represented slightly magnified at Fig. 69, *c*. The larva attains its full growth in June, when it is nearly half an inch long, of a brownish or greenish color, with a shining, yellowish-brown head.



FIG. 69. STRAWBERRY-LEAF ROLLER. *a*, larva, natural size; *b*, front of larva; *c*, moth; *d*, hind end of larva; *b*, *c*, and *d*, magnified.

It is represented natural size at Fig 69, *a*; the head and anterior segments of the body are shown at *b*, and the posterior extremity at *d* of the same figure. The larva pupates within the rolled leaf, and about midsummer emerges as a moth. These moths deposit eggs for a second brood of caterpillars that feed upon the leaves late in summer, changing to pupæ early in autumn, and, passing the winter in that condition, emerge again as moths the following spring, thus completing the cycle of the year. In the Southern States there are three, and possibly four, broods a year.

Remedies.—The best way to destroy this pest is to mow the field soon after the strawberry crop is gathered, and after leaving it a day or two to become dry, burn it over. This will destroy the leaf rollers as well as several other kinds of insects, and the spores of fungous diseases. It is sometimes necessary to scatter a little straw over the field where the leaves are not thick enough to burn well. The plants will not be damaged, but will soon send up a new lot of leaves that will grow rapidly, and be free from insect and fungus attack. If for any reason this method is not desirable, the insects of the second brood may be destroyed by spraying or dusting the plants in August with some poisonous insecticide.

The Strawberry Slug

Emphytus maculatus

The transformations of this insect have been well represented by Dr. Riley at Fig. 70. The four-winged fly (3) appears in spring and deposits its eggs within the tissues of the leaf or stem. The larvæ hatch in a short time, and feed upon the leaf, gnawing small, circular holes at first, like those eaten out of currant and gooseberry leaves by young currant worms. They develop in five or six weeks into pale-green worms (4, 6)



FIG. 70. STRAWBERRY SLUG. 1, 2, pupa; 3, 5, fly; 4, 6, larva; 7, cocoon; 9, egg, magnified.

about three-fourths of an inch long. The larvæ now go slightly beneath the surface, where they form cocoons (7) within which they change to the pupal state (1, 2), and later emerge as flies. In the Southern States there are two broods each season, while at the North there appears to be but one.

Remedies.—The strawberry slug is especially liable to injure young, non-fruiting plantations, where it may easily be destroyed by spraying or dusting with Paris green. On fruiting plantations this method may be used

in localities where a second brood of larvæ appears after the fruit is gathered. Pyrethrum or insect powder may be used in such cases on the first brood. It is probable that burning the fields over early in summer after the crop is gathered will help to hold this insect in check.

INJURING THE BLOSSOMS AND FRUIT

The Tarnished Plant Bug

Lygus pratensis

This is a small yellowish-brown or yellowish-green bug, more or less mottled with dusky, about one-fifth of an inch long (Fig. 71), which is extremely common in nearly all parts of the United States. It attacks a great variety of plants, subsisting upon the sap, and is especially destructive in the strawberry field on account of its injuries to the young fruit, the growth of which it checks, causing an irregular, malformed appearance known as "buttoning." According to Professor Forbes, "the adults pass the winter under rubbish and matted vegetation in a variety of situations. With the earliest warm days of spring they venture forth and collect upon whatever tender vegeta-



FIG. 71. TARNISHED PLANT BUG. Magnified.

tion of tree or shrub offers them a supply of sap within the reach of their rather slender beaks. On their food plants they lay their eggs. The young soon appear, mingled with the adults, as early as the latter part of April and the first of May (in Southern Illinois), and feed with them side by side. By the middle of May the older individuals have matured, and then all stages may be found together upon the same plants; but the winged forms scatter widely, and in June and July are generally distributed wherever suitable food occurs."

There are two, and perhaps more, broods each season. In autumn the adults are to be found abundantly upon golden-rods, sunflowers, asters, and various other fall flowers.

Remedies.—As these bugs obtain their food by sucking, they cannot be destroyed by coating their food plants with poisons. The application of pyrethrum (insect powder) has proven the most successful remedy. By means of a powder gun it can be applied quite readily. Kerosene emulsion also destroys them, and it is claimed that the bugs can frequently be collected in insect nets with profit.

The Strawberry Weevil

Anthonomus signatus

This is a small black snout beetle of the form shown magnified at Fig. 72, *a*, which deposits eggs in the



FIG. 72. STRAWBERRY WEEVIL.

a, beetle magnified; *b*, strawberry spray covered with beetles.

buds of strawberries and blackberries, and then gnaws partly through the stems a short distance below the buds,

causing the latter to wilt and droop (Fig. 72, *a*, *b*). The egg hatches into a little grub that develops in the bud, becoming full-grown in a few weeks, when it resembles, greatly magnified, Fig. 73, *d*. It pupates in the bud, emerging as a perfect beetle about five weeks after the egg is laid. The beetles then migrate to other flowers,



FIG. 73. STRAWBERRY WEEVIL.

a, work in bud and stem; *c*, egg; *d*, larva; *e*, head of larva; *g*, blossom showing location of egg on left, and holes made by beetle; *f*, pupa; *c-g*, magnified.

soon after which they disappear for the season. There are several species of parasites which assist in keeping this insect in check.

Remedies.—Upon this point Dr. C.V. Riley writes: "The first requisite is clean culture. All old strawberry beds and blackberry plants, wild and cultivated, in the

neighborhood of the bearing vines, should be destroyed. The parasites may be encouraged by collecting the injured buds and confining them in a box or barrel covered with fine wire gauze or bobbinet of a mesh small enough to retain the weevils, but of sufficient size to permit the escape of the parasites. A few rows of early flowering, staminate varieties might be planted among beds of later-bearing plants to serve as traps for the hibernating brood, which could then be destroyed by beating them from the flowers into pans of water to which a few drops of kerosene had been added. A perfect preventive may be found in completely covering the beds with frames of muslin or some similar light material. This covering will not only exclude all other injurious insects but is a positive benefit to the berries, which ripen a week or ten days earlier, being superior in size and quality. In addition it secures against frost."

Other Strawberry Insects

The strawberry is subject to attack by a large number of insects besides those discussed above. The roots are often eaten, especially when new plantations are made on land previously in grass, by white grubs; and the stems are sometimes severed by various species of cutworms. The blossom is occasionally attacked by a small thrips (*Thrips tritici*) that prevents the fertilization of the fruit, and by certain caterpillars that devour it. As to the enemies of the foliage, their name is legion: spanworms, leaf rollers, army worms, plant lice, etc., all help to swell the list. And the fruit is not neglected; it caters to the dainty appetite of various ants, myriapods, bugs and beetles. But the pests that are most generally and commonly injurious have been included in the previous pages.

Summary of Treatment.—Strawberry plantations should be rotated with other crops every three, or

in some cases possibly four, years, and old plantations should never be left unplowed to serve as breeding places for insect pests. It is generally advisable to mow and burn over the field soon after the crop is gathered, a method by which many insect and fungous foes may be held in check. Other treatment must be regulated according to the insects present and the circumstances accompanying the attack.

INSECTS AFFECTING CURRANTS AND GOOSEBERRIES

INJURING THE STEM

The Imported Currant Borer

Sesia tipuliformis

This insect is a small, whitish larva that burrows up and down the stems of currants, weakening them so that they are checked in growth and appear stunted and unhealthy. It hatches from eggs deposited singly, on the young stems near the buds, early in summer, by a beautiful, clear-winged, wasp-like moth, with a bluish-black body, and three golden-yellow transverse bands across the abdomen. It measures from tip to tip of the expanded wings nearly three-quarters of an inch. The wings are transparent except at the borders, where they are brownish-black.

A few days after the egg is deposited it hatches into a small larva that gnaws through the stem to the center, where it feeds on the pith. It continues so to do all summer, making a burrow several inches in length. When full grown the larva eats nearly through the stem wall, leaving only the membranous outer bark, and then changes to a chrysalis within the burrow. When the chrysalis is ready to transform it wriggles partially out of this opening, bursting through the layer of membranous bark. It then rests halfway out, its skin splits open in front and the moth crawls out, leaving a mere shell behind. The moth dries and expands its wings.

and flies away. There is but one brood a year. The gooseberry is only occasionally attacked by this pest.

Remedies.—Cutting and burning infested stems in the spring before the moths emerge, is the only practicable remedy that has yet been suggested.

INJURING THE LEAVES

The Imported Currant Worm

Nematus ventricosus

This insect is supposed to have been imported into America from Europe about 1858, since when it has

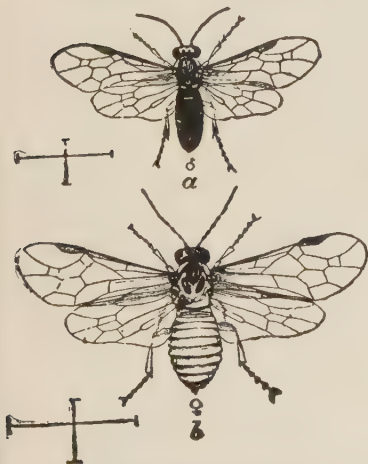


FIG. 74. CURRANT-WORM FLY.
a, male; b, female. Magnified.



FIG. 75. CURRANT LEAF WITH EGGS
OF CURRANT WORM.

spread over a large portion of the United States, and has become the most destructive currant insect.

Early in spring the four-winged flies (Fig. 74) emerge from the tough brown cocoons in which they have hibernated, and deposit rows of small, whitish, glassy eggs on the principal veins of the undersides of

the lower leaves (Fig. 75, 1). In about ten days the small worms hatch and eat circular holes in the leaf, as shown at 2 and 3, Fig. 75. At first these larvæ are whitish in color; they soon change to green, then to green with



FIG. 76. CURRANT WORMS EATING LEAVES.

numerous black spots, and at last back again to a plain light green, with a tinge of yellow at the sides and ends. They are shown at different ages at Fig. 76. The full-grown larvæ spin tough brown cocoons, beneath the leaves and rubbish at the surface of the

ground, within which they change to pupæ. From these cocoons the flies emerge early in summer, to lay eggs for a second brood of worms. As before indicated, the winter is passed within the cocoons, beneath the bushes.

Remedies.—Hellebore is the best remedy for this pest. It may be applied as a dry powder, or in water—one ounce to three gallons. The bushes should be treated soon after the small holes appear in the lower leaves, and again about ~~20~~ days later.

The Currant-leaf Hopper

Empoia albopicta

This is a small, pale-green insect, about one-tenth of an inch long, that occurs upon the under surfaces of the leaves of currants and gooseberries during May and June. They suck out the substance by means of their tiny beaks, which causes white spots to appear on the upper surface of the leaf. This same insect also occurs upon a large number of other plants, sometimes being quite injurious to young apple trees. The chief damage is done by the first brood, the insects leaving the bushes early in the summer, probably preferring at this time the more succulent foliage of other plants.



FIG. 76a. CURRANT-LEAF HOPPER.
Magnified.

Remedies.—Spraying or dusting infested bushes with pyrethrum or insect powder will destroy these little pests, provided it is done before they acquire wings. Tobacco powder is also said by many horticulturists to be an efficient remedy.

The Currant Aphis

Myzus ribis

This is a small, yellowish aphis that is found on the undersides of curled and blistered currant leaves early in summer. Such leaves are generally tinged with red above. The insects apparently migrate to some other plant during the summer, returning to the currant in autumn, and depositing small black eggs upon the stems, especially about the buds.

Remedies.—On account of the deformed condition of the infested leaves, these insects are difficult to reach with insecticides. In garden patches the leaves attacked may be pulled off and dropped into a vessel holding water, with a film of kerosene on top. Spraying with kerosene emulsion quite early in the season, before the foliage has become conspicuously curled, would probably destroy a majority of the aphides then present upon the leaves.

The Four-lined Leaf Bug

Pæcilocapsus lineatus

This insect is a widely distributed pest which for a number of years has done great damage to currants, gooseberries and other plants. Its life history has re-



FIG. 77. FOUR-LINED BUG. Natural size represented in small figure at the right.

cently been worked out by Mr. M. V. Slingerland of Cornell University; to his excellent discussion of the species I am indebted for the figures and information that follow: In the Northern States the four-lined leaf bug generally first appears "about the middle of May on

the newest, tenderest terminal leaves. The insects are then so small and active in hiding themselves that they are not apt to attract attention. Their work, however, soon becomes apparent. Minute semi-transparent darkish spots appear on the terminal leaves. These spots are scarcely larger than a common pin's head, and are round

or slightly angular in shape, depending upon the direction of the minute veinlets of the leaf which bound them. The insect has inserted its beak into the leaf and sucked out nearly all of the opaque green pulp or parenchyma of the interior within a small area bounded by the little veinlets." These spots later turn brown and die; and eventually, as the insects increase in size and destructive power, the leaves become withered and dead, as represented in Plate X, *b*. "When all the tenderest leaves have succumbed, the insect continues its attack on the older leaves lower down. During its lifetime a single insect will destroy at least two or three currant or gooseberry leaves. This accounts for the fact that the injury wrought often seems much out of proportion to the number of insects at work.

"When the insects are very numerous, the growth of the shoots is often checked, they droop, wither and die. Some have thought that this blasting of the growth was caused by a poisonous saliva which the insect injected into the wound made by its beak. However, it is more probable that the shoot dies or its growth is checked on account of the death of its breathing organs—the leaves. On the currant, gooseberry, and many other plants the insect confines its attacks to the leaves, but on some ornamental plants, as the dahlia and rose, the most frequent point of attack seems to be the buds."

Mr. Slingerland has, for the first time, traced the annual cycle of this pest. He finds that "the nymphs

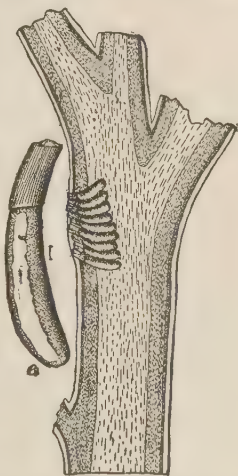


FIG. 78. SECTION OF CURRANT STEM SHOWING EGGS IN POSITION.

e, egg, greatly enlarged.

appear in the latter part of May upon shrubby plants, where they continue to feed upon the tender leaves for two or three weeks, undergoing five molts. The adults appear early in June and often spread to different surrounding succulent plants. Egg laying begins in the latter part of June, the eggs being laid in slits cut in the stems of shrubs near the tips of the new growth. The adults disappear in July and the insect hibernates in the egg. Only one brood occurs each year in New York."

The eggs are deposited in the stems, several being placed side by side in a longitudinal row (Fig. 78). The egg clusters as they appear on the surface of the young shoots are represented in Plate X, *a*.

The four-lined leaf bug shows an extraordinary range of food plants, fifty-four species being listed as attacked by it. "Botanically considered, these lists are of interest, as they show an exceedingly wide range of food plants for a single species of insect. Rarely do we find an insect attacking indiscriminately so many different plants with such widely different characteristics. The fifty-four species of plants represent forty-nine genera in thirty-one different families of the flowering plants. The gymnosperms, like the pine, etc., are not represented, and but one genus (*Hemerocallis*) of the monocotyledons. Fourteen of the plants are useful for food or medicine; twenty-nine are ornamental; while but eleven are wild species. Thus the beneficial results from the attack, rarely severe, of the insect upon the weeds, so termed, is slight compared with its frequently very injurious attacks upon the cultivated plants."

Remedies.—Mr. Slingerland has shown that the nymphs may be killed in May by spraying with kerosene emulsion diluted with five parts of water. The insects may also be destroyed by jarring them into a pan containing water and a little kerosene. This can be done



a



b

PLATE I. INJURIES OF FOUR-LINED LEAF BUG.

at any time of day. The development of the pests may be effectually prevented by pruning and burning, sometime between August and the following May, the tips of the branches in which the eggs have been laid.

The Currant Spanworm

Eufitchia ribearia

This insect is well illustrated in its different stages in Fig. 78 *a*. The mischief is done by the looping cater-



FIG. 78a. CURRANT SPANWORM.

pillar that hatches from eggs laid on the twigs by the slender-bodied, broad-winged moths. There is only one brood each season.

As a rule this insect is not nearly so common as the imported currant worm, but it has occasionally been known to become seriously destructive. The worms are easily destroyed by white hellebore applied in the same way as for the imported species.

INJURING THE FRUIT

The Gooseberry=fruit Worm

Dakruma convolutella

The fruit of the gooseberry, and occasionally of the currant also, is often attacked by a small worm that eats out the substance, leaving only the skin. This is the progeny of an egg laid on the fruit when it was quite small by a spotted, pale-gray moth. Soon after hatching from this egg the larva bores into the berry, and feeds upon the pulp. After it has eaten out one berry it fastens another to it by silken threads, and devours its contents, continuing the process until by the time it is fully grown it has formed a cluster of six or eight injured berries. At this time it is a pale-green caterpillar, three-fourths of an inch long, with a small, brown, horny-looking head. Shortly before the fruit ripens it lets itself to the ground by a silken thread, and concealed among the fallen leaves and rubbish, spins a thin, silken cocoon within which it changes to a brown chrysalis. It remains in this condition until the following spring, when it comes forth as a moth ; consequently there is only one brood of the larvæ each year.

Remedies.—The fruit injured by these caterpillars is so conspicuous that hand picking is a practical remedy. This must be done rapidly as the larvæ wriggle out of the cases and drop to the ground quickly when disturbed. If chickens are allowed to run over the ground after the fruit is gathered they will scratch up and devour many of the pupæ. So also will many be destroyed if the

fallen leaves and rubbish are raked together and burned in autumn.

Other Currant and Gooseberry Insects

There are a number of other insects that occasionally attack these fruits. The stems are sometimes infested by the currant-bark louse (*Lecanium ribis*) and the American currant borer (*Psenocerus supernotatus*); the leaves are attacked by various caterpillars, and the fruit is liable to injury from numerous insects, especially the currant-fruit worm (*Eupithecia interruptofasciata*), the currant fly (*Epochra canadensis*) and the gooseberry midge (*Cecidomyia grossulariæ*). But these species are rarely sufficiently numerous to require special remedial treatment.

Summary of Treatment.—About the only regular treatment currants and gooseberries require is that of spraying or dusting with hellebore, soon after the leaves expand, to destroy the imported currant worm. Stems which at that time show by their drooping foliage and weak appearance that they are probably infested by borers, should be cut and burned.

INSECTS AFFECTING THE RASPBERRY AND BLACKBERRY

INJURING THE ROOTS

The Raspberry-root Borer

Bembecia marginata

The stems of raspberries and blackberries are sometimes injured by a whitish caterpillar with sixteen legs, that bores the root and base of the stem. This is the raspberry-root borer, and the caterpillar hatches from an egg deposited by a clear-winged moth upon the cane, a few inches above the soil surface. The larva, after hatching, eats into the center of the stalk, where it devours the pith, working downward toward the root. It spends the winter in the root, feeding upon its substance, and in spring works upward again, generally in another cane than the one in which it descended. A few inches above the ground it gnaws almost through the stem wall, leaving the thin outer membrane intact. It then pupates inside the cane, near the partial opening. A short time later the pupa wriggles through the hole, bursting the outer membrane, and stops when about halfway out. Then the skin splits open and the moth comes forth. Canes attacked by these borers often wither and die, and the injury is sometimes attributed to "winterkilling."

Remedies.—No other remedy than that of cutting out the larvæ, or pulling up and burning the infested

canes, has yet been discovered. Fortunately this insect is rarely sufficiently numerous to do serious injury. It occurs in wild as well as cultivated sorts.

INJURING THE LEAVES

The Raspberry Slug

Monophadnus rubi

The raspberry slug or raspberry sawfly is a four-winged black fly with a reddish abdomen, which deposits its eggs during spring in the raspberry leaf. The eggs soon hatch into small whitish worms that feed upon the soft tissues of the tender foliage. In a few weeks they become full-grown. They are then about three-fourths of an inch long, of a dark green color, and have the body thickly covered with spinose tubercles. The slugs now descend to the ground and construct rather firm cocoons slightly beneath the soil surface. They remain in these cocoons until the following spring, when they come forth as the adult flies.

Remedies.—These insects can easily be destroyed by dusting or spraying the infested bushes with powdered hellebore. In spraying, use from one-half to one pound of hellebore to fifty gallons of water.

INJURING THE CANES

The Raspberry-cane Borer

Oberea bimaculata

The adult of this insect is a slender-bodied, black beetle, with a yellow collar just behind the head. It appears early in summer, usually during June in the Northern States, and deposits eggs in the green canes of raspberries and blackberries. The process of oviposition is peculiar; the beetle makes two transverse rows of punctures about half an inch apart in the cane, towards the

tip, and midway between these she deposits the egg. The rows of punctures make up a kind of girdling which causes the tip of the cane to wither. A short time after the egg is deposited it hatches into a small cylindrical larva that bores downwards through the pith. By autumn they have frequently reached the bottom of the cane, where they change to pupæ, and the following June emerge again as beetles.

Remedies.—Soon after the canes are punctured by the beetle they wilt; consequently, if they are examined about midsummer, affected canes can easily be distinguished, and they should then be cut off below the lower ring of punctures and burned. If the injury is noticed later, the whole cane should be pulled up and destroyed to be sure to get the larva.

The Snowy Tree Cricket

Oecanthus niveus

Serious damage is frequently done in raspberry plantations by a small white tree cricket, which deposits its eggs in longitudinal rows in the green canes. One of these rows as it appears when the insect has completed its work is represented at Fig. 79, *a*, and the cane split open to show how the eggs are inserted is shown at *b* of the same figure. At *c* may be seen one of the elongated, slightly curved, yellow eggs, considerably magnified, with an opaque, granulated cap at the upper end; *d* is a more highly magnified view of this cap. The eggs hatch early in summer into young crickets bearing a general resemblance to the adults, though without wings. They feed upon plant lice and other insects during their entire existence, being consequently in this way friends rather than foes of the fruit grower. By the latter part of summer they become fully grown. They are then of

a pale, whitish-green color, about four-fifths of an inch long, and nearly of the form represented at Fig. 80, which is a closely related species. The female cricket deposits her eggs in the tender, growing canes of raspber-



FIG. 79. EGGS OF SNOWY TREE CRICKET. *a*, egg punctures; *b*, cane split open to show eggs; *c*, egg magnified; *d*, egg cap, more magnified.



FIG. 80. TREE CRICKET.
Magnified.

ries, blackberries and grapes, and the twigs of maple, willow, catalpa, and several other species of trees. The injury thus done often causes the raspberries to die beyond the punctures, or else the damaged canes are broken off during the winter.

Remedies.—Trimming out and burning during fall or winter the canes containing the eggs is about the only practicable remedy known.

The Red-necked Agrilus

Agrilus ruficollis

One may often find near the base of the canes of raspberries and blackberries a peculiar gall formation resembling Fig. 81, *a*. If such a gall is cut open it will

be seen that the form is due to the excessive growth of the bark. This injury is caused by a slender whitish worm that hatches from an egg laid in summer by a small elongate beetle (*c*) in the axil of a leafstalk usually not far from the soil. The young larva burrows through the inner bark, sometimes penetrating to the pith, and frequently girdling the cane. Its presence causes the abnormal growth manifested in the formation of the gall. In autumn the



a



FIG. 81. RED-NECKED AGRILUS. *a*, gall; *c*, beetle, magnified.

larva enters the central pith, burrowing up or down in it some distance. The following spring it pupates and early in summer emerges as an adult beetle, which is about one-third of an inch long, "somewhat tapering toward the end of the body, bronze brown in general color, but with a coppery-red or brassy neck or thorax,

which makes it easily recognized and gives the name to the species. It is found during bright sunshiny days in late May, all of June and half of July, on the upper surface of the leaves, eating little round holes, but not doing any perceptible injury in this stage. The beetle is quite active, and flies readily, or if surprised, it will fold its legs and drop to the ground, remaining quiet until the danger is over."

Remedies.—Upon this point Professor J. B. Smith writes: "The mode of checking and avoiding future injury by this species is obvious, and requires only a little additional work when trimming. As early in the spring as may be, and certainly by the middle of April, the canes should all be carefully examined and cut away below the galls. If these are at or near the surface of the ground, the entire cane must be sacrificed. It might possibly bear some fruit; but it would certainly mature a beetle which would destroy a dozen other canes, and this would be poor economy. As the plants are all pruned each spring in any case, it means simply a little more care and judgment exercised in the work at a somewhat greater expense of time. After the cutting, all the twigs and other rubbish should be raked out, and at once burned. If the cut canes are left in the field, the beetles will mature as well as if no cutting had been done, and nothing is gained. Every gall should be cut out and destroyed before the beginning of May. This will prevent maturing of the beetles, and the field will be exempt from further injury unless specimens come on from other sources. This fact makes it important that growers should co-operate in the work; and that, as already suggested¹ some means should be provided to compel all engaged in blackberry culture to prevent their land from becoming a nuisance to their neighbors."

The Pithy Blackberry Gall

Diastrophus nebulosus

The peculiar large galls represented in Fig. 82, *a*, are sometimes found on blackberry canes. These are caused by a small fly which deposits eggs in the cane.



FIG. 82. PITHY GALL. *b*, cut open; *c*, larva; *d*, pupa; *c*, *d* magnified.

The eggs hatch into small grubs that cause the malformed growth; they feed upon the tissues, each making a little cell in which they finally pupate, to emerge later as adult flies. The holes through which they come are

seen at *a*; the larva—natural size and magnified—at *c*, and the pupa magnified at *d*. Certain parasites prey upon these insects, which are seldom sufficiently abundant to do noticeable injury. Cutting and burning the galls is an easy remedy when necessary.

Other Raspberry and Blackberry Insects

Raspberries and blackberries are subject to attack by various insects besides those discussed in the foregoing pages. Certain galls are sometimes found upon the roots, due usually to the raspberry-root gallfly (*Rhodites radicum*). The foliage is sometimes eaten by various caterpillars or beetles, and the fruit is occasionally infested by the flea-like negro bug, or the raspberry spanworm (*Synchlora rubivoraria*). But these various insects as a rule only do an incidental injury, and are rarely sufficiently numerous to require special remedial treatment.

INSECTS AFFECTING THE GRAPE

INJURING THE ROOT

The Grape-root Borer

Sciapteron polistiformis

The roots of grapes are sometimes found to be attacked by a whitish, cylindrical caterpillar with sixteen legs, which bears a strong general resemblance to the peach-tree borer. This is the insect named above. "When full-grown," according to Dr. Riley, "the larva measures from an inch to an inch and three-quarters, and it then forms a pod-like cocoon of a gummy sort of silk, covered with little bits of wood bark and dirt. Within this cocoon it becomes a chrysalis, which in due time, by aid of rows of minute teeth with which it is furnished, works its way out of the cocoon to the surface of the ground and gives forth the moth. As with the peach borer, this insect requires a year to develop, and is found in its different states of larva, chrysalis and moth, throughout the summer months, and it doubtless also passes the winter as a larva." The moth is a wasp-like creature, black, with bright yellow bands across the abdomen.

Remedies.—This insect is rarely seriously injurious. When a vine shows by its weak or drooping appearance that it is suffering from an injury at the root, the earth should be dug away and the borers searched for, as is done with the peach borer. It has been suggested that mounding about the base of the vine with earth would prevent the deposition of eggs.

The Grape Phylloxera

Phylloxera vastatrix

The grape phylloxera is the worst insect enemy of the vineyardist. Its ravages have ruined thousands of acres of grapes in France and other European countries, and much damage has been done by it in America. There are two forms of it, one inhabiting the roots (represented in its various stages in Fig. 85), and one in-



FIG. 83. PHYLLOXERA GALLS ON GRAPE LEAF.

habiting the leaves (Fig. 84), upon which it forms minute galls (Fig. 83).

Entomologists and horticulturists are indebted to Dr. C. V. Riley for the elucidation of the life history of this curious insect, which, in his Seventh Report as State Entomologist of Missouri, he has summarized as follows: "It hibernates mostly as a young larva torpidly attached to the roots, and so deepened in color as generally to be of a dull brassy-brown, and, therefore, with difficulty perceived, as the roots are often of the

same color. With the renewal of vine growth in the spring, this larva molts, rapidly increases in size, and soon commences laying eggs. These eggs in due time give birth to young, which soon become virginal, egg-laying mothers, like the first; and like them, always remain wingless. Five or six generations of these parthenogenetic, egg-bearing, apterous mothers follow each other; when—about the middle of July, in this latitude—some of the individuals begin to acquire wings.

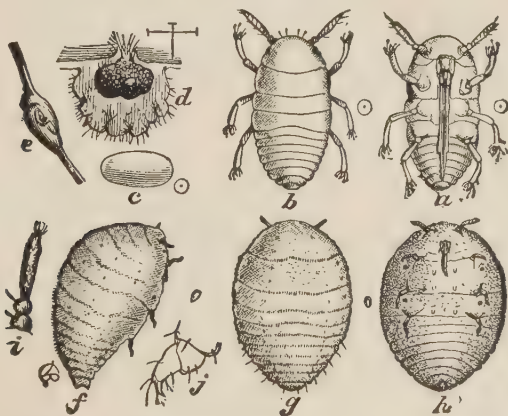


FIG. 84. GRAPE PHYLLOXERA, LEAF FORM. *a, b*, newly hatched nymphs, dorsal and ventral view; *c*, egg; *d*, section of gall; *e*, swelling of tendril; *f, g, h*, mother of gall louse, lateral, dorsal and ventral views; *i*, her antenna; *j*, two-jointed tarsus. Natural sizes indicated by small dots or figures.

These are all females, and, like the wingless mothers, they are parthenogenetic. Having issued from the ground, while in the pupal state, they rise in the air and spread to new vineyards, where they deliver themselves of their issue in the form of eggs or egg-like bodies—usually two or three in number, and not exceeding eight—and then perish. These eggs are of two sizes, the larger about 0.02 of an inch long, and the smaller about three-fifths of that length. In the course of a

fortnight they produce the sexual individuals, the larger ones giving birth to females, the smaller to males. These sexual individuals are born for no other purpose than the reproduction of their kind, and are without means of flight, or of taking food, or excreting.

"They are quite active and couple readily, one male being capable, no doubt, of serving several females; the abdomen of the female, after impregnation, enlarges

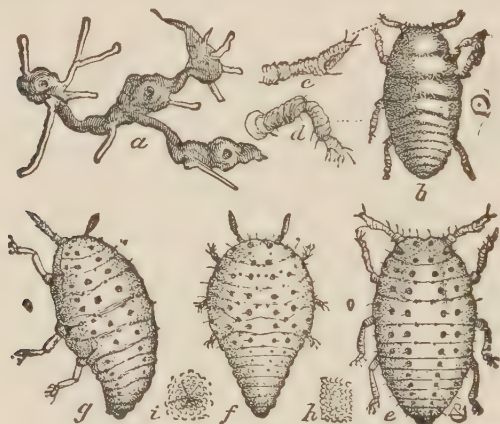


FIG. 85. GRAPE PHYLLOXERA. ROOT FORM. *a*, infested rootlets; *b*, hibernating larva; *c*, *d*, antenna and leg of same; *e*, *f*, *g*, more mature form; *h*, granulations of skin; *i*, tubercle; *j*, transverse folds at border of joints; *k*, simple eyes.

somewhat, and she is soon delivered of a solitary egg, which differs from the egg of the parthenogenetic mother only in becoming somewhat darker. This impregnated egg gives birth to a young louse which becomes a virginal, egg-bearing, wingless mother, and thus recommences the cycle of the species evolution. But one of the most important discoveries of Bolbiana is that, during the latter part of the season, many of the wingless, hypogean mothers perform the very same function as the winged ones; *i. e.*, they lay a few eggs which

are of two sizes and which produce males and females, organized and constructed precisely as those born of the winged females, and like them producing the solitary impregnated egg. Thus, the interesting fact is established that even the winged form is by no means essential to the perpetuation of the species; but that, if all such winged individuals were destroyed as fast as they issue from the ground, the species could go on multiplying in a vineyard from year to year. We have, therefore, the spectacle of an underground insect possessing the power of continued existence, even where confined to its subterranean retreats. It spreads in the wingless state from vine to vine and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself, or over the surface. At the same time it is able, in the winged condition, to migrate to more distant points. The winged females, as before stated, begin to appear in July, and continue to issue from the ground until vine growth ceases in the fall. Yet they are much more abundant in August than during any other month, and on certain days may be said to literally swarm. Every piece of a root a few inches long, and having rootlets, taken from an infested vine at this season, will present a goodly proportion of pupæ; and an ordinary quart preserve jar, filled with such roots and tightly closed, will furnish daily, for two or three weeks, a dozen or more of the winged females, which gather on the sides of the jar toward the light. We may get some idea, from this fact, of the immense numbers that disappear through the air to new fields, from a single acre of infested vines, in the course of the late summer and fall months. If to the above account we add that occasionally individuals abandon their normal underground habit, and form galls upon the leaves of certain varieties of grapevine, we have, in a general way, the whole natural history of the species."

Remedies.—In America comparatively little has been done in a practical way in fighting this insect, because its injuries here are usually not serious. But in Europe a great deal has been accomplished in preventing its injuries. According to Dr. Riley the means employed there “consist in (1) methods which avoid the necessity of direct treatment, comprising the use of American stocks and planting in sandy soils; (2) the employment of insecticides (bisulphide of carbon, sulphocarbonate of potassium, and the kerosene emulsion); and (3) submersion.”

INJURING THE LEAVES

The Grapevine Flea-beetle

Graptodera chalybea

This is a small, steel-blue beetle (Fig. 86, *d*) that is often very destructive to grapevines. It hibernates as an adult. As soon in spring as the buds begin to swell the beetles come forth and attack them. The injury at this time is often great, because the immature leaf and flower buds are so easily destroyed. The beetles continue feeding for three or four weeks, during the latter part of the time depositing small orange-yellow eggs in clusters on the undersides of the leaves. They then die, and in a few days the eggs hatch into small, dark-colored larvæ that feed upon the foliage. As they grow older they gnaw irregular holes in the leaves, giving them a ragged and unsightly appearance (Fig. 86, *a*). When fully grown (three or four weeks after hatching) they are about three-tenths of an inch long, brown in color, with six legs, and four or five black dots on the back of each ring or segment of the body. The head is black, and there are numerous hairs on the body. One is shown somewhat magnified at *b*, Fig. 86. When fully grown

the larvæ leave the vines, and, entering the soil, form earthen cocoons (*c*), within which they change to pupæ. A few weeks later they again transform and emerge as perfect beetles. These also feed upon the foliage and lay eggs for a second brood of larvæ.



FIG. 86. GRAPEVINE FLEA-BEETLE. *a*, leaf infested by larva; *b*, larva, magnified; *c*, cocoon; *d*, beetle, magnified.

Remedies.—Spraying with Paris green (three ounces to fifty gallons water) is probably the best remedy for this pest. They may also be destroyed by pyrethrum or insect powder. On cool mornings the beetles are quite sluggish, and may be collected by jarring them on sheets.

The Rose Chafer

Macrodactylus subspinosus

This insect has been known for nearly a century as a serious enemy of the horticulturist. It is distributed over a large portion of the United States, but appears to be injurious only in certain localities where areas of low, sandy bottom lands offer unusual opportunities for it to multiply. It feeds in the beetle state upon a very great variety of trees and plants, often being exceedingly injurious to the flowers or foliage of apples, pears, plums, peaches, roses, raspberries, blackberries, grapes and other plants.

The adult rose chafer, rose beetle or rose bug, is a hard, brown insect, not quite half an inch long, of the form represented at Fig.



FIG. 87. ROSE CHAFER. *a*, larva; *b*, pupa; *c*, beetle. Slightly magnified.

87, *c*. It makes its appearance early in summer, about the time grapes come into blossom, and feeds upon the flowers, foliage or fruit of the plants already mentioned. After pairing, the females deposit thirty or more eggs an inch or so be-

neath the soil surface, preferring for this purpose, according to Dr. Riley's observations, "low, open meadow land or cultivated fields, particularly where the soil is light and sandy." In two or three weeks the eggs hatch into grubs that feed upon the roots of grass, and possibly other plants, and become fully grown (*a*) in autumn. As winter approaches they go deeper into the soil, coming to the surface again in spring, and making for themselves rude, earthen cells in which they change to the pupal state (*b*). Three or four weeks later they again

change, and the perfect beetle comes forth. Thus there is but one brood a year. The insect lives in the beetle state about a month.

Remedies.—There is, perhaps, no fruit insect so difficult to combat as this. As yet no practicable method of destroying it in its breeding grounds has been found, and the success attending the various preventives of beetle injury has been by no means universal. Spraying or dusting with pyrethrum or insect powder has been found to stupefy the beetles temporarily, and will occasionally prove useful in protecting fruits. A single rose bush or grapevine may be covered with mosquito netting, but of course this is impracticable on a large scale. In regions where the beetles are not overwhelmingly abundant, thorough spraying of grapevines and fruit trees with a wash made by adding three or four pecks of freshly slaked lime and a quart of crude carbolic acid to fifty gallons of water, has been reported by several fruit growers to be successful, although on the other hand, some who have tried it in a smaller way say it did little or no good. A better method, which has been reported successful in Rhode Island, is to spray the buds before the blossoms open—in the State named the spraying was done the first week in June—with one pound Paris green to fifty gallons Bordeaux mixture. In parts of New Jersey, hand picking has been resorted to as the only sure method of extermination, the insects being collected in the cooler hours of the day. They may be destroyed also by hot water, provided it is hot enough when it touches them. On the whole the arsenited Bordeaux mixture seems the most promising remedial measure for most localities where the beetles are not overwhelmingly abundant.

The Spotted Grapevine Beetle

Pelidnota punctata

This insect has been known for years to attack grapevines, but it has rarely been reported to do really serious injury to them, probably because it usually is present in such limited numbers that its depredations are insignificant. The larva (Fig. 88, *a*) feeds on the decaying roots of various trees, and resembles somewhat the common white grub of meadows—the larva of the May beetle. Its general color is whitish, with the head chestnut-brown. It

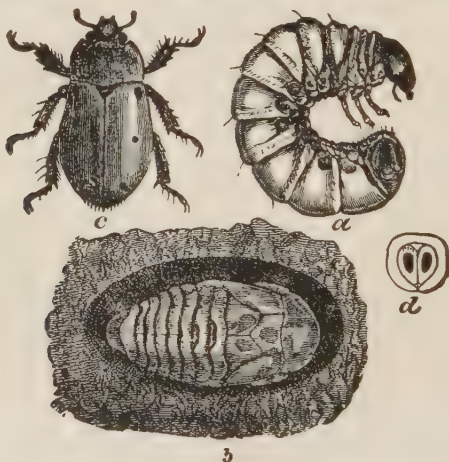


FIG. 88. SPOTTED GRAPEVINE BEETLE.
a, larva; *b*, pupa; *c*, beetle.

is supposed to require three years to complete its development. When full-grown it forms a sort of cocoon, within which it changes to the chrysalis or pupal state, to emerge about a fortnight later as an adult beetle.

The general color of the upper surface of the beetle is a dull yellowish-brown, but the thorax is darker and somewhat bronzed, and the under surface is of a bril-

liant metallic greenish-black hue. There are three distinct black dots on each of the wing covers, and also one on each side of the thorax. The beetle usually feeds upon the foliage of wild and cultivated grapevines, and also on the Virginia creeper, but sometimes attacks green grapes, biting holes through the skin and so ruining the fruit.

Remedies.—The only practical remedy so far proposed is that of collecting the beetles by hand and destroying them. As they fly especially just at dusk, this is the best time for accomplishing the work.

Grape Sphinx Moths

The grape forms the favorite food of several species of large and handsome sphinx moths. As there is not



FIG. 89. THE ACHEMON SPHINX.

space to discuss each of these, we will take the achemon sphinx (*Philampelus achemon*) as an example. The adult of this species is one of the most beautiful of the hawk moths. It measures three and a half inches across

its expanded wings, and is brownish gray in color with lighter brown variegations and deeper brown spots arranged on the front wings, as shown in the figure. The posterior wings are pink, more reddish toward the middle, and having a wide grayish border along the hind margin, on the front edge of which is a row of dark

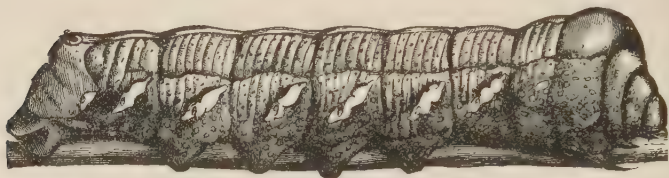


FIG. 89a. LARVA OF ACHEMON SPHINX.

spots. These moths make their appearance during June and July, flying about grapevines and various flowers at dusk, and depositing their eggs on the undersides of the leaves of grape and Virginia creeper. Within a few days these eggs hatch into little larvæ that feed upon the foliage, growing so rapidly that by September they are



FIG. 89b. PUPA OF ACHEMON SPHINX.

nearly four inches long and as thick as a man's finger (Fig. 89a). At this time different individuals vary greatly in color, some being straw yellow and others reddish brown. There are six cream-colored spots along the sides, and numerous little dots scattered over the body. The head and first two body segments are smaller than the rest, allowing the caterpillar to draw them partially inside the next one back.

The fully grown caterpillar descends to the ground, and entering the soil several inches forms a smooth oval cell, within which it changes to a dark, shining brown pupa or chrysalis. It remains in this condition until the following year, when it emerges as a moth again.

The green grapevine sphinx (*Darapsa myron*) and the pandorus sphinx (*Philampelus pandorus*) are closely related to the achemon sphinx and similar to it in life history and habits. All three species are subject to the attacks of a small parasitic fly that spins oval cocoons upon the backs of the caterpillars, as



FIG. 90. CATERPILLAR WITH COCOONS OF PARASITE. Adult parasite at right; latter magnified.

shown at Fig. 90, which represents the larva of the green grapevine sphinx so infested. The life history of these little creatures has already been described in the Introduction (p. 10).

Remedies.—Fortunately these sphinx larvæ seldom become sufficiently numerous to do serious injury. They are so conspicuous both on account of their size and the defoliated condition of the branches upon which they are at work, that hand picking is usually a sufficiently simple and practical remedy.

The Abbot Sphinx

Thyreus abbotii

This is a comparatively rare species, and has never been known to do serious injury in vineyards. The moth (Fig. 91), a handsome, chocolate-brown insect, measuring two and a half inches across the expanded wings, appears in spring, and deposits eggs upon the grapevines. The larva soon hatches, and feeds upon the leaves, becoming

fully grown during the latter part of summer. It is then about two and a half inches long, yellowish or reddish-brown in color, and of the form represented in the upper illustration of Fig. 91. It now descends to the ground, where it forms a loose cocoon, within which it changes



FIG. 91. ABBOT SPHINX. Larva and moth.

to the chrysalis state, remaining in that condition until the following spring, when it emerges as a moth again.

Remedies.—Unless this insect becomes much more numerous than it has been heretofore, it can easily be held in check by a little hand picking.

The Grapevine-leaf Hopper

Typhlocyba vitis

This little insect is frequently called the grape thrips, but its more proper name is the one given above, as it is not a thrips at all, but a true leaf hopper. It is a beautiful little creature, about one-tenth of an inch long, yellow with bright-red markings, and of the form represented at Plate IX, Fig. 5 (p. 136). “They make their first appearance,” says Dr. Harris, “on the leaves

in June, when they are very small and not provided with wings, being then in the larval state. During most of the time they remain perfectly quiet with their beaks thrust into the leaves, from which they derive their nourishment by suction. If disturbed, however, they leap from one leaf to another with great agility. As they increase in size they have occasion frequently to change their skins, and great numbers of their empty cast skins, of a white color, will be found throughout the summer adhering to the undersides of the leaves, and upon the ground beneath the vines. When arrived at maturity, which generally occurs during the month of August, they are still more agile than before, making use of their delicate wings as well as their legs in their motions from place to place; and when the leaves are agitated they leap and fly from them in swarms, but soon alight and begin again their destructive operations. The infested leaves at length become yellow, sickly, and prematurely dry, and give to the vine at midsummer the aspect it naturally assumes on the approach of winter. In autumn the leaf hoppers desert the vines, and retire for shelter during the coming winter beneath fallen leaves, and among the decayed tufts and roots of grass, where they remain till the following spring, when they emerge from their winter quarters, deposit their eggs upon the leaves of the vine, and perish."

Remedies.—If the vines are dusted early in the season, before the leaf hoppers have acquired wings, with pyrethrum (insect powder) or tobacco dust, by means of some apparatus like Leggett's powder gun, the pests will be destroyed by the million. This appears to be the most promising remedy for them. Some vineyardists catch them on a sheet saturated with kerosene or covered with tar, the sheet being stretched on a frame which is carried along one side of the row, while somebody goes along the other side of the vines and frightens the insects toward it.

The Grapevine-leaf Roller

Desmia maculalis

This is a slender, somewhat flattened, yellowish-green caterpillar, measuring when full-grown about three-quarters of an inch, that rolls the leaves of grapevines, fastening the sides together by silken threads. It hatches from an egg laid on the leaf by a pretty little dark-brown moth, expanding nearly an inch, and having several conspicuous white spots on its wings. The larva

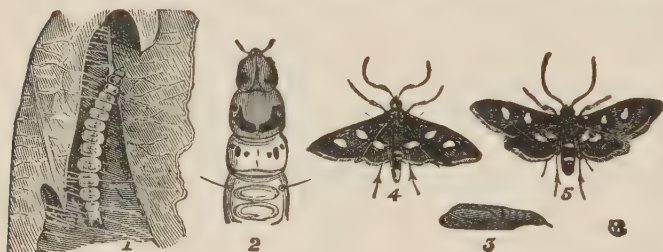


FIG. 92. GRAPE-LEAF ROLLER. 1, larva; 2, head of same, magnified; 3, pupa; 4, 5, moth.

usually pupates within the folded leaf. There are two broods each season, the first brood of larvæ pupating about midsummer, to emerge as moths shortly afterwards, and the second pupating in autumn and hibernating as chrysalids.

Remedies.—This insect is seldom sufficiently numerous to require remedial treatment. The larvæ may be crushed within their cases, or the cases picked off and burned late in autumn, before the leaves fall off, if they threaten to become seriously destructive.

The Beautiful Wood Nymph

Eudryas grata

This is a very handsome insect, both in its immature and adult stages. The moth (Fig. 93, *g*) measures nearly two inches across its expanded front wings, which are of a glossy creamy-white color, beautifully marked with purple, brown and green. It lays its eggs on the underside of the leaves. The larvæ soon hatch



FIG. 93. BEAUTIFUL WOOD NYMPH. *a*, larva; *e*, *f*, egg, magnified; *g*, moth.

and feed upon the foliage, developing rapidly, so that by the latter part of summer they are full-grown (*a*), the body being of a pale bluish color, crossed by bands and lines of orange and black. The larvæ now leave the vine and seek some concealed situation in which to pupate. They pass the winter in the chrysalis state, and emerge the following spring as moths.

Remedies.—This insect is rarely injurious, probably because it is kept in check by certain parasites. It can be destroyed if it should become too numerous by

hand picking, or by spraying or dusting the infested vines with pyrethrum or hellebore.

INJURING THE FRUIT

The Grape-berry Moth

Eudemis botrana

Grapes are frequently injured by having their substance eaten out by a small, whitish worm that fastens three or four berries together with silken threads, and devours the contents of each. This insect is the larva or caterpillar of the grape-berry moth, a species imported many years ago from Europe, where it has long been known as an enemy of the vine. The adult is a small, bluish moth that deposits its eggs late in June or early in



FIG. 94. GRAPE-BERRY MOTH.
a, moth; *b*, larva; *d*, injured fruit.

July. The very young caterpillar is found within the skin of the grape, devouring the contents. When it has finished one it gnaws its way out and enters a neighboring berry, fastening the two together with silken threads (Fig. 94, *d*). In this way three or four berries are frequently destroyed by a single larva, which, when fully grown, is about a quarter of an inch long, of a dull green color tinged with red, and covered with a few short hairs. It pupates on the leaf, first cutting out a crescent-shaped flap which it binds down by means of silken threads,

forming a snug, tight cocoon. About a fortnight later, in southern latitudes, the moths appear, to lay eggs for a second brood, which hibernates in the pupal state.

Remedies.—The only remedies as yet suggested are those of gathering and burning the fallen leaves in autumn or early winter, or picking and burning injured fruit, being sure to get the larva with it.

Other Grape Insects

The grape is subject to attack by many insects besides those discussed in the preceding pages. The roots are sometimes bored by the gigantic larva of two species of *Prionus*—the broad-necked *Prionus* (*P. laticollis*) and the tile-horned *Prionus* (*P. imbricornis*)—but these insects usually infest only grapevines planted on new land and are seldom injurious in older fields. The branches are attacked by a variety of species, including certain tree hoppers, the maple-bark louse, the red-shouldered *Sinoxylon* (*S. basilaris*), and certain gall-making insects. The enemies to the foliage of the grape are legion, and include insects of varied habits and natural orders. The fruit is sometimes injured by the larva of a small snout beetle called the grape curculio (*Craponius inaequalis*), and also by a very minute larva that occurs inside the seed, the grape-seed maggot (*Isosoma vitis*). But these insects are seldom really injurious.

Summary of Treatment.—The grape is subject to attack by so great a variety of insect enemies that it is difficult to give any general directions for the season's treatment. It must largely be regulated according to the insects present. Clean culture, however, is always advisable, as it lessens the opportunities for many species to survive the winter successfully.

PART III

INSECTS AFFECTING SHADE TREES,
ORNAMENTAL PLANTS, AND
FLOWERS



PLATE XI. THE WOOLLY ALDER APHIS.

INSECTS AFFECTING SHADE TREES

INJURING THE TRUNK

The Sixteen-legged Maple Borer

Sesia acerni

In many portions of the Union, especially throughout the Central States, maple trees are often seriously injured by a small whitish larva that burrows through the sapwood and inner bark. Unlike the ordinary wood-boring grubs, this insect has sixteen legs and resembles a small caterpillar. It is about half an inch long; the head is yellow and the legs are reddish. The burrows are filled with brownish castings. It hatches from eggs laid on the bark, nearly always where the latter is cracked, bruised or otherwise injured; the attack of this species often follows that of the flat-headed borer. The egg-laying parent is a small handsome day-flying moth, having clear wings and the general form represented in Fig. 95, *c*; the head is reddish, the thorax yellowish, and the abdomen bluish black more or less marked with yellow and having a reddish tuft at the hind end. The front wings are bluish black blotched with yellow. The larvæ feed upon the sapwood and inner bark for several months, often girdling the tree, before they become full-grown. They then burrow almost through the outer bark, leaving a thin layer untouched; next they form slight oval silken cocoons (*b*) within the burrows, and inside of these they change to chrysalids. When ready for the final change, each chrysalis wriggles forward,

ruptures the thin layer of bark and pushes itself about halfway out of the opening; then the chrysalis shell breaks open and the moth emerges, leaving its empty chrysalis case behind it, as shown in *d* of the accompanying figure. The moths emerge early in summer and soon after deposit their eggs.



FIG. 95. MAPLE BORER. *a*, caterpillar; *b*, cocoon; *c*, moth; *d*, pupa case.

Remedies. — Keeping the bark smooth and free from cracks or other injuries is an important preventive of the attacks of this insect. It is also stated that their injuries may be prevented by applying to the trunks early in summer a mixture of lye and soft soap, it being more effective if a little Paris green is added.

Spraying the trunks thoroughly with the Bordeaux mixture and Paris green combination might prove an effective preventive.

INJURING THE BRANCHES

Willow=twig Aphides

Melanoxanthus sp.

The various species of willow are particularly subject to the attacks of aphides or plant lice. No less than nine of these insects have been described as preying upon them. No part of the tree, except possibly the root, is exempt from attack, and the bark and twigs receive the exclusive attention of at least five species. Some of these often become seriously injurious, and

more frequently, perhaps, their presence is extremely annoying where they occur upon shade or ornamental trees in private grounds or public parks.

The aphides most commonly found upon willow twigs belong to the genus *Melanoxanthus*. Three American species of the genus are known. The willow-grove aphis (*M. salicti*) is probably the commonest in the Eastern and Middle States. It is similar in appearance and habits to the nearly related flocculent willow-twig aphis, represented in Fig. 96. This insect lives over in the egg state on the bark of willow twigs. Early in

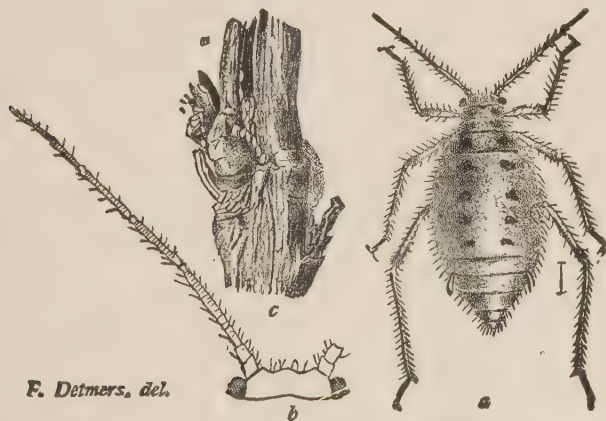


FIG. 96. FLOCCULENT WILLOW APHIS. *a*, oviparous female; *b*, head and antenna; *c*, eggs on bark.

spring the eggs hatch into young plant lice which insert their tiny beaks into the tender bark and suck out the sap. They grow rapidly, and each one soon becomes the mother of several young aphides. The generation from the egg are all wingless, but those of the second generation probably develop into both winged and wingless forms, which are also viviparous. Successive broods continue to appear throughout the entire summer, all

being viviparous, and some having wings while others have none. By midsummer they have often increased so enormously as to cover all the twigs of infested trees, making them appear filthy and unsightly, as well as impairing their vitality by extracting the sap. A single one of the aphides hatched from the egg in spring may become the ancestor of many millions before autumn. But in October a true sexed generation develops, the males being winged and the females wingless. By the union of these two, the true eggs are obtained.

The wingless forms, whether viviparous or oviparous, do not differ materially in appearance. The oviparous, or egg-laying, form is about one-fifth of an inch long, bluish black in color, with a glaucous bloom. It has a distinct white longitudinal line along the middle of the back, and a row of white spots along each side. The cornicles, or honey tubes, are bright orange-yellow. The male is one-fifth of an inch long, with a wing expanse of one-third of an inch. The body is bluish black, with the wings transparent and their veins yellowish brown.

The oviparous females congregate for the purpose of depositing their eggs in one or a few places on the tree, where they cover the bark with them. The egg is about one-twentieth of an inch long and oval in form; when first laid it is covered with a liquid which on exposure to the air dries into a thin, grayish, irregular covering, suggestive of felt.

Remedies.—Spray with kerosene emulsion; cut off and burn the limbs on which the eggs are laid.

The Toothed Willow Aphis

Lachnus dentatus

This is the largest of the aphides affecting the willow, being in fact one of the largest known species of this family. The wingless forms are one-fourth of an inch long. Its life history is much like that of the spotted willow aphis described above, except that it prefers the trunk and larger limbs to the twigs. The sexed individuals appear in autumn, and the eggs are probably laid upon the bark. The species is characterized by a large tooth-like tubercle on the middle of the back of the abdomen.

Remedies.—A strong kerosene emulsion sprayed upon the bark will destroy these creatures.

The White-pine Aphis

Lachnus strobi

This insect is a widely distributed species, and on account of its egg-laying habits it is liable to be introduced everywhere with pine trees from nurseries. It frequently becomes so numerous as to do serious injury to white pines in ornamental grounds.

Like most plant lice, this species reproduces viviparously, or by giving birth to living young, during the summer, but on the approach of cold weather the sexual individuals are produced. During October these are usually the only forms present, the oviparous females being congregated in great numbers upon the bark of the smaller branches, with their heads nearly always directed towards the trunk of the tree. When disturbed they move about rapidly, usually attempting to conceal themselves on the other side of the branch. At such times they also have a curious habit of waving their

long hind legs in the air, probably for the purpose of frightening away predaceous or parasitic enemies.

The oviparous female is represented, much magnified, at Fig. 97. It is nearly one-fifth of an inch long, shining black more or less tinged with brown, and orna-



FIG. 97. WHITE-PINE APHIS.
Oviparous female. Magnified.

mented with spots and stripes of white. The wingless viviparous females do not differ essentially from this form. The winged male is about one-eighth of an inch long, with a wing expanse of a quarter of an inch. It is blackish, with a slight glaucous bloom, and a whitish longitudinal line along the middle of the back. The wings are subhyaline, with the veins dark brown, and the stigma almost black. The antennæ and legs

are quite hairy. The eggs are deposited during October and November, on the leaflets, in rows. Each egg is not quite one-tenth of an inch long, elongate-oval, brownish when first laid, but becoming black in a short time.

Remedies.—Kerosene emulsion is the most effective insecticide with which to combat this insect. It should be sprayed upon the infested trees early in the season, before the aphides become too abundant. The best time to apply it would be just after the young lice hatch from the eggs; they are then very tender and easily killed.

The Woolly Alder Aphis

Pemphigus tessellata

In the Eastern States one may often see upon the branches of alders a peculiar white woolly growth, resembling that shown on Plate XI. This white substance develops upon the bodies of a peculiar plant louse that lives upon the alder stems. Like other aphides these insects reproduce by giving birth to living young, by which means they are able to increase very rapidly. In autumn vast numbers of young are born; they crawl down the stems to the ground where they congregate in enormous numbers in the crevices between the base of the trunk and larger roots and the soil, or beneath the fallen leaves or other rubbish at the soil surface. Here they remain until spring, when they take advantage of the first warm days to crawl up the trunk to the twigs, where they establish colonies on the young growth. Each aphis inserts its beak into the bark and sucks out the sap. At the same time they produce on their backs a white pulverulence which forms a protective covering. In a week or two they mature and begin giving birth to living young, and thereafter during the season one generation is produced after another until cold weather. No sexual forms of this species have yet been found.

There are usually to be found associated with the colonies the peculiar black excrescences represented in Plate XI. This is due to a fungus which develops on the abundant juices—the so-called honeydew—excreted by the aphides.

Remedies.—In case it was desired to get rid of these insects on alder in parks or private grounds it could easily be done by spraying the bare stems and the ground beneath in early spring with a strong kerosene emulsion.

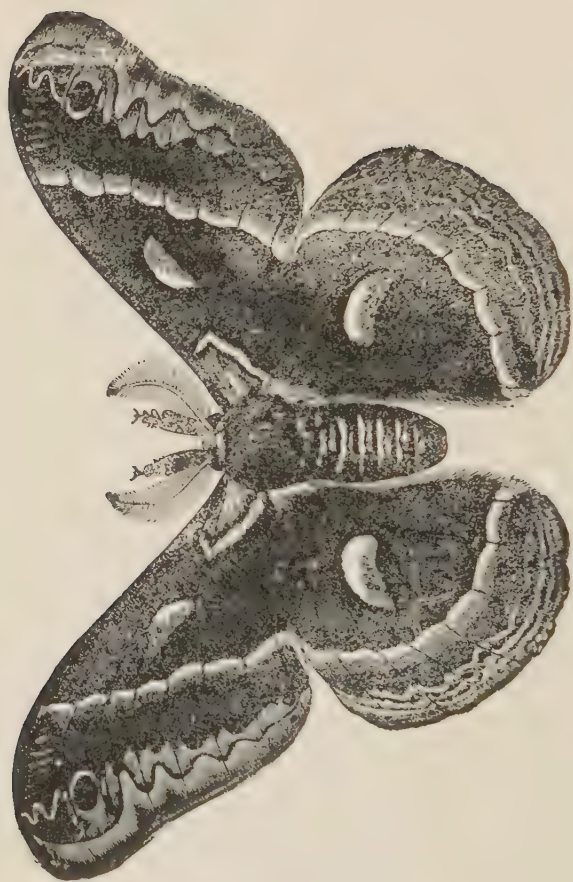


PLATE XII. CECROPIA EMPEROR MOTH.

INSECTS AFFECTING SHADE TREES

INJURING THE LEAVES

The Cecropia Emperor Moth

Platysamia cecropia

People are often puzzled during winter over large, peculiar, grayish-brown cocoons (Fig. 99) that occur not infrequently on the limbs of maple, apple, pear, cherry, and a great variety of fruit and shade trees.

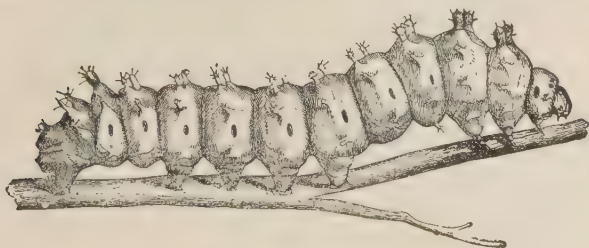


FIG. 98. CECROPIA CATERPILLAR.

These are the cocoons of one of the largest and handsomest American insects—the cecropia emperor moth, illustrated, natural size, at Plate XII. This moth often measures six or seven inches across the front wings, the ground color of all the wings being a grizzled, dusky brown, with the hind margins clay-colored; near the middle of each wing there is an opaque, kidney-shaped, dull-red spot, having a white center and a narrow black edging, and beyond the spot there is a wavy, reddish band bordered internally with white. The fore wings,

next to the shoulders, are dull red with a curved, white band, and near the tips of the same is an eye-like black spot within a bluish-white crescent. The upper sides of the body and the legs are reddish; the fore part of the thorax and the hinder edges of the rings of the abdomen are white; the under surface of the body is checkered with red and white.

The moths come forth from the cocoons in June and deposit their eggs on the various kinds of trees upon which the larvæ live. About a week later the eggs hatch into small, spiny caterpillars, that devour the foliage and rapidly increase in size. They are very vora-

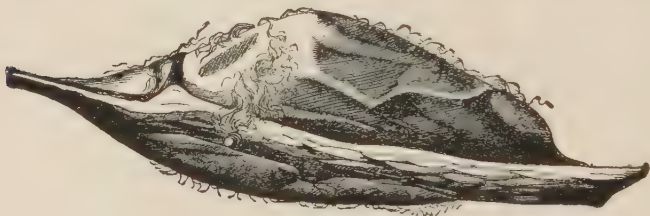


FIG. 99. COCOON OF CECROPIA MOTH.

cious, and reach maturity late in summer. They are then (Fig. 98) often over three inches long, as thick as a man's thumb, and have, along the back, rows of large, coral-red tubercles. Early in autumn they spin their silken cocoons, within which they change to dark-brown pupæ, remaining in this condition until the following summer, when they come forth as moths to lay eggs for another brood.

There are several species of parasites that prey upon the cecropia caterpillars. On this account they only occasionally become injurious.

Remedies.—By spraying with the arsenites, or hand-picking the larvæ or cocoons, this insect may be easily checked when it threatens to become destructive.

The White-marked Tussock Moth

Orgyia leucostigma

This insect is one of the most destructive leaf-eating caterpillars, and during recent years has done much damage in many cities and villages. The larva feeds upon the foliage of a great variety of fruit and shade trees.

If the trunks or larger limbs of maple, apple, elm, or any other of the trees infested by this insect, be examined any time in autumn or winter, after the leaves have fallen, one may find scattered here and there upon the bark thin gray cocoons, many of which will be covered with large bunches of spherical white eggs, fastened



FIG. 100. CATERPILLAR OF WHITE-MARKED TUSSOCK MOTH.

together by a protecting froth-like mass. In May, soon after the leaves come out, these eggs hatch into small caterpillars, which at once begin eating the foliage about them. They continue to devour it for six or seven weeks, when they become full-grown. They are then very handsome (Fig. 100) and measure a little over an inch. The general color is bright yellow. The head and two tubercle-like projections on the hinder portion of the back are of a bright coral-red. There are four cream-colored tufts of hair along the back. Two long black plumes project forward from just behind the sides of the head, and another projects backward from the

posterior end of the body. About the middle of July the caterpillars spin thin, whitish cocoons upon the rougher bark, and about a fortnight later come forth as moths. These lay eggs for a second brood, which completes its transformations before winter sets in. The pupa of the female (Fig. 101, *c*) is larger than that of the male (*d*). The male moth differs greatly from the female moth, the former being winged (*e*), while the latter is wingless (*a*). The female crawls upon the top



FIG. 101. WHITE-MARKED TUSOCK MOTH. *a*, female moth on cocoon; *b*, young larva hanging by thread; *c*, female pupa; *d*, male pupa; *e*, male moth.

of the cocoon (*a*) as soon as she emerges from the pupal state, where, after mating with the male, she deposits her eggs in a single mass and dies.

Remedies.—The increase of this insect is greatly checked by several parasitic enemies, nearly a dozen species of two-winged and four-winged flies being known to prey upon it. The caterpillars may be destroyed by spraying the infested trees with the arsenites—Paris green or London purple; or the egg masses may be picked off the bark in winter.

The Fall Webworm

Hyphantria cunea

The work of few insects is more universally known than that of the fall webworm. Late in summer and early in autumn the conspicuous, unsightly webs of this pest may be seen in nearly every orchard and hedgerow over a large portion of the United States. The adult is a pretty, white moth (Fig. 102), which deposits eggs on the leaves of various trees early in summer. These soon hatch into young caterpillars that begin at once to spin a protective web.

The young worms are of a pale yellow color, sparsely covered with hairs, and have a black head and two rows of black marks upon the body. They feed upon the parenchyma of the foliage, leaving the



FIG. 102. FALL WEBWORM. a, larva; b, pupa; c, moth.

network of veins, and grow quite rapidly, enlarging the web as they develop. By the time they are full-grown a single lot of them will destroy the foliage of a good-sized branch, making it very conspicuous on account of the web-like covering. At this time the larvæ are a little more than an inch long (a), with the body densely clothed with yellowish hairs. They now leave their nests and descend to the ground, where just beneath the surface, or under some suitable shelter above the surface, they spin slight, silken cocoons within which they change to the chrysalis state. At the North there is but one brood each year, but in the Southern States there are two.

Remedies.—The webs of this insect are so conspicuous that it is an easy matter to cut them off and burn or crush the larvæ. This is a simple remedy, and the earlier it is done the better. The pest may also be destroyed by spraying with London purple or Paris green when the larvæ are young.

The Imported Elm-leaf Beetle

Galeruca xanthomelæna

During the recent years this insect has been exceedingly destructive in many cities of the Eastern States to that loveliest of shade trees—the elm. It has long been known in the Old World, having been especially injurious in France and Germany, and is supposed to have been imported into America during the early part of the present century. The eggs (Fig. 103, *a*) are laid on the underside of the leaf in two or three rows, each group consisting of from five to twenty eggs. At *e* in the figure they are shown considerably magnified, and as will be seen they are very close together, and fastened securely to the leaf. In about a week the larvæ hatch and begin eating the leaves, causing them to look as if riddled with fine shot. They become fully grown (*g*) in two or three weeks, when they descend to the ground, and, finding some convenient shelter, change to pupæ (*j*). Ten days later the perfect beetles (*c*, natural size; *k*, magnified) come forth and eat the leaves, although the damage done by the insect in this beetle state is much less than that done by the young, growing larvæ. There are three or four broods each season, and the beetles pass the winter in whatever shelter they can find, especially congregating in hollow trees, and under old leaves.

Remedies.—This pest can be held in check by spraying with London purple or Paris green (4 ozs. to

50 gals. water). The application should be made when the eggs are being laid, in order to kill the larvæ before they have done any damage. The addition of a little



FIG. 103. ELM-LEAF BEETLE. *a*, eggs; *b*, larvæ; *c*, beetle—all natural size; *e*, eggs; *g*, larva; *j*, pupa; *k*, beetle; *e* to *k* magnified.

flour to the poison mixture seems to render it more effective. To reach the tops of high trees a pump of considerable power is required.

The Bagworm

Thyridopteryx ephemeraeformis

The twigs of various deciduous and coniferous trees are often infested during the winter months by small bags or sacs (of the form shown at Fig. 104, *e*) suspended to the leaves or branches. If one of the larger of these bags be cut open, there will be found within it a brown, membranous shell (the pupa case of the moth) filled

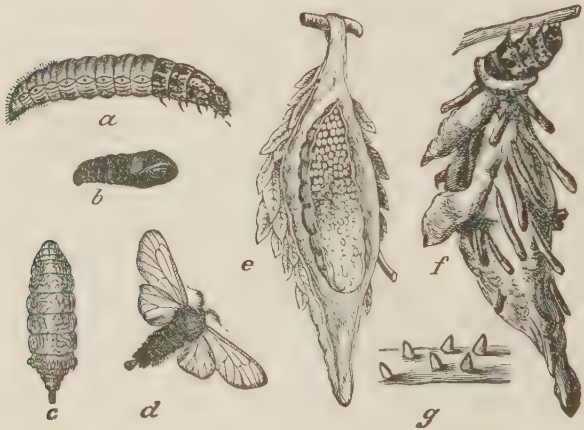


FIG. 104. BAGWORM. *a*, larva; *b*, male pupa; *c*, female moth; *d*, male moth; *e*, bag and pupa case cut open to show eggs; *f*, full-grown larva with bag; *g*, young larvæ with their conical coverings.

with many small yellow eggs (*e*). In this condition the bagworm or basket worm passes the winter. Late in spring the larvæ hatch, and at once form little cases of fragments of leaves fastened together by silken threads. Beneath these cases (*g*) they feed upon the foliage, enlarging them as the larvæ develop, and during later life using bits of twigs or stems in their construction, instead of leaf particles. The full-grown larva is represented in its bag at *f*, and without it at *a*. When fully

developed the worms descend to the earth by means of silken threads, and crawl about until they reach the bases of other trees, which they ascend. This is the way the species migrates. The larvæ pupate within the cases, and about three weeks later change to moths.



FIG. 105. BAGWORM CASES (ON TREES. *a*, red cedar; *b*, maple; *c*, arbor vitæ; *d*, spruce; *e*, white pine.

The two sexes of the moths differ greatly, the male (104, *d*) having well-developed wings, while the female (*e*) is wingless. The latter deposits her eggs in the empty pupa case from which she has emerged, and falls to the ground, where soon afterward she dies.

The bagworm feeds upon a great variety of trees, and apparently prefers coniferous to deciduous sorts. Red cedar and arbor vitæ are especially subject to attack. Its injuries are sometimes very severe on shade trees in city streets and public parks. There are several parasitic insects that prey upon the larvæ.

Remedies.—The simplest remedy for this insect is that of spraying with London purple or Paris green. This should be done in early summer when the worms are young. Effective work also can be done, according to Dr. Riley, “during the winter time or when the trees are bare. The bags which contain the hibernating eggs, and which are very easily detected then, may be gathered or pruned and burned. This work may be so easily done that there is no excuse for the increase of this species. Where intelligent action is possible, the bags were better collected and heaped together in some open enclosure away from trees, rather than burned. By this means most of the parasites will in time escape, while the young bagworms, which will in time hatch, and which have feeble traveling power, must needs perish from inability to reach proper food.”

The Green-striped Maple Worm

Anisota rubicunda

In many Western States maple trees are regularly defoliated by a large caterpillar, alternately striped with light yellowish-green and dark-green, having two long, black horns on the second segment behind the head, and other similar but shorter horns on the posterior segments (Fig. 106, *a*). This is the green-striped maple worm. It is the larva of a handsome, yellowish-pink moth (*c*), sometimes called the rosy Dryocampa. These moths appear early in summer, and lay their eggs on the undersides of the maple leaves in clusters varying

from forty to eighty each. The larvæ hatch in a week or ten days, and feed upon the foliage, being gregarious at first, but gradually spreading as they grow older. In a few weeks they become fully developed as larvæ, having molted four times, when they descend to the ground, where, just beneath the soil surface, they change to dark-brown pupæ (*b*). About a fortnight later they come forth as moths again. These moths, which usually appear during July or August, lay eggs for a second brood of larvæ that develop during late summer or early

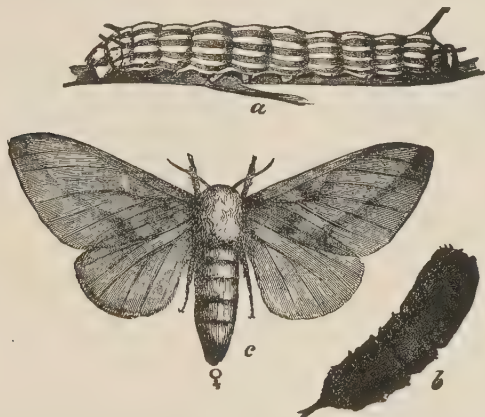


FIG. 106. GREEN-STRIPED MAPLE WORM. *a*, larva; *b*, pupa; *c*, moth.

autumn, and pass the winter as pupæ, emerging as moths the following summer.

The second brood of larvæ are much more numerous, and consequently more destructive, than the first. Although maple forms the favorite food plant of the insect, it is occasionally found upon oaks and a few other trees. The larvæ are preyed upon by various insectivorous birds, and by several insect parasites.

Remedies.—Spraying with London purple or Paris green early in the season, just after the worms hatch, is the most effective remedy for this insect.

The Walnut Caterpillar

Datana angusii

The leaves of walnut and butternut trees are frequently eaten during summer by a large, blackish caterpillar. This is the larva of a good-sized moth that makes its appearance from the middle of June to the first of July, and deposits its eggs, seventy to a hundred in a place, on the under surface of the leaves. In a



FIG. 107. YELLOW-NECKED APPLE WORM. *a*, larva; *b*, moth; *c*, eggs—all natural size; *d*, egg, magnified.

short time the larvæ hatch and begin feeding upon the foliage. They increase rapidly in size, and in a few weeks attract attention on account of the defoliated twigs where they have been at work. They are gregarious in habit, and at the times of molting, or casting of the skin, they migrate in a body to the trunk of the tree, frequently descending nearly to its base, and, piling themselves one upon another, remain in a solid mass until the process is completed. Then they crawl back to the twigs and begin feeding again. When fully grown as caterpillars, they go to the ground and change to the pupal state, just beneath the soil surface. Here they remain until early the following summer, when they emerge as moths to lay eggs for another brood.

A fair idea of the appearance of the walnut caterpillar and its moth may be obtained from Fig. 107, which represents a closely related insect—the yellow-necked apple-tree caterpillar. When at rest or alarmed the larvæ assume the peculiar position represented at *a*. These caterpillars are preyed upon by certain birds, notably the blue jay and red-headed woodpecker, and by various species of insect parasites.

Remedies.—These defoliators may be destroyed by spraying their food plants with Paris green or London purple, or the larvæ may be crushed when gathered into heaps on the trunk at molting time.

The Woolly Maple-bark Louse

Pulvinaria innumerabilis

The presence of this insect is manifested in the spring and early summer by the occurrence upon the twigs of maple trees, especially on the underside, of a brown, circular, leathery scale, about one-quarter of an inch in diameter, beneath which is a peculiar, fluffy, cottony mass (Fig. 108, *a*). In the spring there may be found in each of these masses great numbers (from 700 to 1000) of small, white, spherical eggs. Early in summer these eggs hatch into young lice, which scatter over the trees, wandering about on the twigs and leaves for a few days, and, finally, fixing themselves upon the lower leaf surface, insert their tiny beaks and suck out the sap. They remain in this position several weeks, when a few of them become fully developed winged males. These mate with the remainder, which are females, and soon die. But the females remain upon the leaves until nearly time for them to fall in autumn, when they desert them and migrate to the twigs, attaching themselves by inserting their beaks into the bark. Here they re-

main until the following season, the eggs gradually developing and being deposited during spring.

These insects sometimes do great damage to maple trees. They excrete or secrete a peculiar liquid which falls upon the leaves and the ground beneath the trees, and which is sometimes called "honeydew." There are a large number of parasitic and predaceous insects that

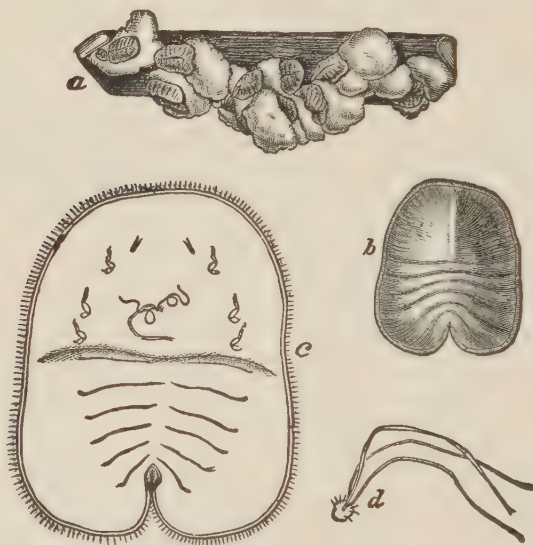


FIG. 108. MAPLE-BARK LOUSE. *a*, cottony scales on twigs; *b*, back view of scale, magnified; *c*, ventral view of scale, more magnified.

prey upon this species and suppress its periodical uprisings.

Remedies.—In cities where a stream of water from hose connected with waterworks is available, the trees can be largely cleared of the pests by repeated drenchings. In the spring before the eggs hatch, and also while the young lice are crawling over the tree, soon after hatching, is the best time for this work. The

young lice may also be easily destroyed by spraying with kerosene emulsion. This should be done in June, soon after they hatch.

The Box-elder Bug

Leptocoris trivittatus

In the region west of the Missouri river this insect is extremely abundant, causing serious injury to the box elder, and occasionally, also, to ash, maple, and other trees. The adult (Fig. 109) is a dull-black bug about half an inch long, having blood red ocelli, and various red markings on the wings and body. "During the winter," according to Professor E. A. Popenoe, who has studied the insect carefully, "the adults are hidden in sheltered nooks and corners everywhere, but are especially abundant in crevices of stone walls and angles of stone buildings, on the south sides of which they appear, singly and in clusters, every warm day during the season. As soon as the increasing warmth of spring allows, they leave these shelters and seek the trees attacked by them. The eggs are laid in creases of the bark, on the trunk and twigs. After midsummer their gregarious tendency is manifested in the flocking of bugs of all sizes and in great numbers, in lines up and down the trunks and branches, the company including larvæ of all sizes, pupæ, and fully matured individuals. This habit persists more or less completely until October and November, or until the trees are bare. During the warm days of Indian summer the bugs fly everywhere, flocking to the warm sides of the buildings, and entering houses, where, though otherwise harmless, they become troublesome through their abun-



FIG. 109. BOX-ELDER BUG. Magnified.

dance and propensity to fall clumsily into pails of water, crocks of milk, and other articles of food left uncovered."

This insect, like all true bugs, is active during its entire existence, and gets its food by sucking sap through a sharp-pointed beak which is inserted into the bark of the succulent twigs, and also into the leaves. It has comparatively few natural enemies.

Remedies.—These bugs may easily be destroyed when gathered in clusters on trees or walls by pouring boiling water, gasoline or kerosene upon them.

The Gypsy Moth

Ocneria dispar

The gypsy moth is one of the most troublesome insects in Europe. It feeds on an extraordinary variety of plants, attacking almost everything, and is difficult to destroy by natural or artificial means. As is well known, it was introduced into the vicinity of Boston twenty-five years ago and has since become very destructive in that region.



FIG. 110. GYPSY MOTH. Male.

In 1891 the legislature of Massachusetts established a commission for the extermination of the insect, and has since appropriated a large amount of money to carry on the work, which has already checked the outbreak to a remarkable degree. It is much to be hoped that the work will be continued unabated for several years.

There is an idea somewhat prevalent that this insect could be exterminated by importing parasites, but this is fallacious. In my opinion it would be a great mistake to abandon the work of extermination and leave it

to be done by parasites. Under the most favorable conditions there could only result a long series of oscillations in the numbers of the moths, in which periods of destruction would alternate with periods of immunity.



FIG. 111. GYPSY MOTH. Female.

The later stages of the gypsy moth are illustrated in the accompanying figures. The male moths are much smaller than the females. "The full-grown caterpillar is about an inch and three-fourths in length,

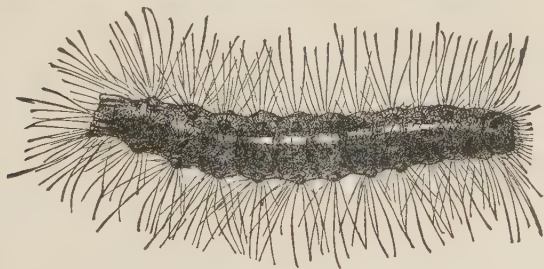


FIG. 112. GYPSY-MOTH CATERPILLAR.

very dark brown or black, finely reticulated with pale yellow. There is a pale yellow line along the middle of the back and a similar one along each side. On the first six segments following the head there is a bluish

tubercle, armed with several black spines on each side of the dorsal line, and on the remaining segments these tubercles are dark crimson-red. In the middle of the tenth and eleventh segments there is a smaller red tubercle notched at the top. The whole surface of the body



FIG. 113. CHRYSALIS OF GYPSY MOTH.

is somewhat hairy, but along each side the hairs are long and form quite dense clusters."

Various methods of controlling this pest are in use in Massachusetts. The most important are those of spraying with arsenate of lead to kill the young caterpillars, and the mechanical destruction of the eggs.

INSECTS AFFECTING THE ROSE

INJURING THE LEAVES

The Rose Slug

Monostegia rosæ

This insect is familiar to most lovers of the queen of flowers, and is justly dreaded on account of its serious injuries. But no one should allow it to prevent the planting and enjoyment of roses, for it is easy to keep the pest in check.

The rose slug is the young or larva of a four-winged sawfly, related to the parent of the pear-tree slug and the imported currant worm. It bears a general resemblance to the adult pear-tree slug. The larvæ shown in Fig. 114 will serve to illustrate the appearance and mode of work of the rose slug. According to Dr. Harris, the parent sawflies, in the latitude of Massachusetts, "come out of the ground at various times between the 20th of May and the middle of June, during which season they pair and lay their eggs. The females when about to lay their eggs turn a little to one side, unsheath their saws, and thrust them obliquely into the skin of the leaf, depositing in each incision thus made a single egg. The young begin to hatch in ten days or a fortnight after the eggs are laid. The period of their existence in the caterpillar state probably does not exceed three weeks. They have a small, round, yellowish head, with a black dot on each side of it, and are provided with

twenty-two short legs. The body is green above, paler at the sides, and is soft and almost transparent, like jelly. The skin of the back is transversely wrinkled, and covered with minute elevated points; and there are two small, triple-pointed warts on the edge of the first ring, immediately behind the head. These gelatinous and sluggish creatures eat the upper surface of the leaf in large, irregular patches, leaving the veins and skin beneath untouched; and they are sometimes so thick that not a leaf on the bushes is spared by them, and the



FIG. 114. PEAR-TREE SLUG.

whole foliage looks as if it had been scorched by fire and drops off soon afterwards. They cast their skins several times, leaving them

extended and fastened to the leaves; and after the last molting they lose their semi-transparent and greenish color, and acquire an opaque, yellowish hue. They then leave the bushes and burrow an inch or more in the earth, where each one makes for itself a small, oval cell of grains of earth, cemented with a little gummy silk." They remain in these pupa cells until the following season, when they emerge as flies.

There are two other species of slugs affecting the rose, and in some places these are more abundant than the one here described. An account of their habits may be found in the Report of the U. S. Department of Agriculture for 1892, p. 161. The same remedial measures apply to all three species.

Remedies.—In cities where a stream of water from a sprinkling hose is always available, the simplest plan of keeping these pests away is to spray the bushes forcibly every day or two, to frighten away the flies and wash off the larvæ. If this process is gone through

with sufficient force and thoroughness, it is the neatest and best remedy. The slugs also may be easily killed by spraying or dusting the infested bushes with hellebore or insect powder.

The Rose-leaf Hopper

Typhlocyba roseæ

Owners of rose bushes are frequently annoyed by finding the lower sides of the leaves covered with a small white insect that sucks out the cell contents and gives the upper surfaces a peculiar white-spotted appearance. This is the rose-leaf hopper, a species that has been known to injure these lovely ornamental plants for nearly a century. The adult, shown considerably magnified at Fig. 115, *a*, is a little more than one-tenth of an inch



FIG. 115. ROSE-LEAF HOPPER. *a*, adult; *b*, pupa. Magnified.

long, with a yellowish-white body, and white, semi-transparent wing covers. In common with other leaf hoppers this insect has long hind legs, by means of which it is enabled to make tremendously long leaps when disturbed. The fully grown nymph (*b*) is also whitish, and its back is well protected by numerous long spinous hairs. There are said to be several broods each season.

Remedies.—These little pests are much easier to destroy before they are fully developed than afterwards. Spraying or dusting the infested plants with pyrethrum or insect powder is a simple and efficient remedy. Tobacco, in the form either of a powder or a decoction, is also good; and kerosene emulsion will destroy the pests.

INSECTS AFFECTING FLOWERS IN THE WINDOW GARDEN AND GREENHOUSE

INJURING THE LEAVES

Plant Lice or Aphides

There are many different species of aphides, plant lice, or "green flies," affecting the various flowering plants. But all are quite similar in life history and



FIG. 116. APHIS. *a*, wingless form, magnified; *b*, winged form, magnified; *c*, same, natural size.

habits, and the same remedies apply to each. They all multiply with marvellous rapidity on account of their habit of giving birth to living young, without the presence of male aphides. They mature rapidly, and obtain food by in-

serting their pointed beaks into the stem or leaf, and sucking out the sap. There are generally two forms of them, one being winged (Fig. 116, *b*, *c*) and the other wingless (*a*). These insects are the commonest pests of flowering plants.

Remedies.—Tobacco is the great specific for these insects. It may be used in various forms, but generally the most satisfactory form is that of the refuse powder

of the cigar factories. This should be used freely as a mulch for low-growing plants, such as the daisy; and if blown upon infested plants, having first sprayed them with water, by means of a powder bellows or Leggett's powder gun, it will clear them readily. In greenhouses tobacco stems are commonly used to smoke the plants. A few live coals are put upon a shovel, or into a metal bucket, and refuse tobacco stems are laid upon them. The house is then tightly closed and the smoke allowed to remain several hours. The greatest objection to this method is that tender plants are liable to be seriously injured by an overdose of the smoke. The tobacco may also be used in the form of a decoction, made by pouring hot water on the stems, allowing it to cool, and then drawing off the liquid. This may be sprayed upon the plants, or, where not too large, the plants may be dipped into the liquid. For window gardens this is perhaps as satisfactory a method as can be suggested.

The Red Spider

Tetranychus telarius

Greenhouse plants are often seriously injured by multitudes of very minute reddish mites that congregate on the lower leaf surface, spinning a very fine protective web, and sucking out the juices of the plants through their infinitesimal beaks. These little creatures are commonly called red spiders. They are distantly related to ordinary spiders, and like them have, when fully developed, four pairs of legs. They multiply beneath their silken webs, where one may find colonies of individuals (so small as to be scarcely visible to the naked eye) in all stages of existence. The young have but three pairs of legs. The egg is very small and spherical, being nearly colorless. The infested leaves assume a yellowish hue, and many of them finally drop off.

Remedies.—The red spider flourishes best in a dry atmosphere. It is seldom troublesome in greenhouses where the air is kept saturated with moisture and the plants are sprayed with water every day. In window gardens the plants should be sprayed with soapsuds, tobacco decoction or kerosene emulsion, or dusted with fine tobacco powder or insect powder, as soon as they show signs of the presence of this pest.

Mealy Bugs and Scale Lice

Mealy bugs are among the commonest and most vexatious greenhouse pests. They occur upon a great variety of plants, and reproduce freely throughout the year. There are two or three species commonly found in this country, the most destructive, perhaps, being the species called by entomologists *Dactylopius adonidum*, which is distinguished by two long, white, cottony threads extending backward from the last segment of the abdomen. Another common species is called *Dactylopius destructor*.

Mealy bugs derive their common name from a peculiar yellowish-white substance, resembling flour or meal, which they throw out from numerous minute pores along the sides of their bodies. This serves both as a protection from enemies, and also as a place of concealment for the eggs of the insects.

Woody greenhouse plants, such as the oleander orange, abutilon, etc., are also often infested with scale insects that occur upon the stems, sucking out the sap and so absorbing the vitality of the plants. These belong to the same family of insects as the mealy bugs, to which they bear a general resemblance in life history and habits.

Remedies.—When a plant is once badly infested with either of these pests it can be cleared only by the

ough and careful work. As many should be rubbed or brushed off by hand as possible, and then the plant may be sprayed with kerosene emulsion, which, however, should be used with caution on the more tender varieties of greenhouse plants. It is not necessary to treat the whole plant, but only the parts infested by the insect. In case only a few mealy bugs are present they may be killed by dipping a small brush in alcohol and then saturating the colonies of the insect with it. Or the affected part of the plant may be washed with a forcible stream of water till all signs of the insects or their eggs are removed. Professor Comstock reports an experiment in which equal parts of smoking tobacco and flowers of sulphur were ground together in a mortar until thoroughly mixed, and the compound thus formed was dusted over wet infested plants, and the mealy bugs destroyed.

Out of doors, and to a certain extent in the greenhouse also, these mealy bugs and scale insects have various natural enemies to contend with. Chief among these are the little ladybugs and certain parasitic flies.



PART IV

INSECTS AFFECTING VEGETABLES



PLATE XIII. THE TOMATO-WORM SPECIES.

INSECTS AFFECTING THE TOMATO

INJURING THE LEAVES The Tomato Worm

Protoparce celeus

This insect in its larval state is familiar to every one who has owned a garden. The moths, which belong to the handsome sphinx family, appear early in summer, and fly about just at dusk, sipping the nectar from various flowers through their long tongues or sucking tubes. Their general appearance is well illustrated

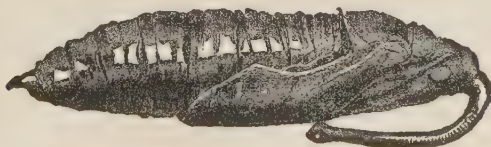


FIG. 117. PUPA OF TOMATO WORM.

at Plate XIII. The ground color of the body and wings is gray, and there are various dots and stripes of different shades. On each side of the abdomen are five orange-colored spots. The female moths lay the eggs in the evening on tomato plants, where they soon hatch into green worms that feed voraciously on the foliage. These caterpillars grow rapidly, and in a few weeks become three inches long and nearly as thick as a man's finger. They are light green, with several oblique, whitish stripes along each side of the body; sometimes brown specimens are found. Early in September, in the Northern States, these caterpillars complete their larval growth, and bur-

row into the ground some distance, where they form oval cells in the soil, shed their larval skins, and change to pupæ. The pupa or chrysalis (Fig. 117) is of chestnut-brown color, with a long and slender tongue case bent over like the handle of a jug. They remain in this state until the following summer, when they come forth as moths. Besides the leaves, the caterpillars often feed upon the green fruit of the tomato, as well as upon the foliage of the potato and tobacco.

There is another species similar to this one, and often confounded with it. The life history and habits of the two are much alike. The moth of the other one



FIG. 118. TOMATO WORM WITH COCOONS OF PARASITE.

is called the Carolina sphinx (*Protoparce carolina*). In the Southern States, and even as far north as Central Ohio, there are two broods each season.

The tomato worm is subject to the attacks of a small, four-winged black fly that deposits eggs beneath its skin along the back. The eggs hatch into little maggots that absorb the body juices of the worm, developing at its expense, and finally coming out upon its back, where they spin white, silken cocoons (Fig. 118), within

which they change to pupæ. Shortly afterward they again change to flies that gnaw out of the cocoons and fly away to continue the work of destruction. The caterpillar lingers awhile in a half-dead condition, and finally dies.

Remedies.—Hand-picking the worms is the most effective remedy for garden patches. Their depredations are so conspicuous that it is generally easy to find them. The moths may be destroyed (and consequently the deposition of eggs prevented) by smearing flat boards in various parts of the field with molasses mixed with stale beer, to which a little fly poison has been added. The boards should be a foot or two from the ground. Another method which is especially recommended for killing the moths in tobacco fields, is to plant, at occasional intervals in the field, seed of Jamestown weed (*Datura stramonium*) about the time the tobacco is put out. These will come in blossom when the moths appear. If a little fly poison, mixed with sweetened water and whiskey, be poured in the long blossoms each evening, the moths that sip the liquid will be killed.

INSECTS AFFECTING THE POTATO

INJURING THE STEM

The Potato-stalk Weevil

Trichobaris trinotata

Potato stems are sometimes infested by a whitish or yellowish-white, footless grub, about a quarter of an inch long, which burrows in the heart of the stalk, especially near the ground, and causes the plant to wilt and die. This is the larva of a small, grayish snout beetle, called the potato-stalk weevil, the females of which deposit their eggs, singly, in a slit made for the purpose

in the stem, slightly above the soil surface. In a few days the egg hatches into a little grub that burrows down the center of the stem toward the root.



FIG. 119. POTATO-STALK WEEVIL. A few weeks later, still within the stalk and slightly below the surface of the ground, the larva pupates, and late in summer or early in autumn it emerges as an adult weevil. This weevil passes the winter under whatever protective covering it may find, and the following season starts another generation by depositing its eggs in the potato stalks.

The injuries of this insect are sometimes quite severe. In Iowa, during the season of 1890, Professor C. P. Gillette estimated that seventy-five per cent. of

the potato plants were infested by it. It is a widely distributed species.

Remedies.—According to Professor Gillette, “the only remedy at present known is to pull the vines as soon as they are found wilting and burn them. If the tops are left until it is time to dig the potatoes many of the beetles will have matured and escaped, and these will live over winter and lay eggs for another brood.” But even late pulling and burning will destroy many of the pests, and in regions where this insect is known to be at work, the vines should be burned when pulled up in harvesting the crop.

INJURING THE LEAVES

The Colorado Potato Beetle

Doryphora decemlineata

This insect originally lived upon a wild variety of *Solanum* (the genus to which the cultivated potato belongs) in the West, near the base of the Rocky Mountains. It was not known as an injurious species until about 1860, when it attacked potatoes in the gardens of settlers in Kansas and neighboring States, and thereafter gradually spread eastward until it finally reached the Atlantic coast, and was carried across to Europe, becoming extremely destructive wherever it appeared.

The adult Colorado potato beetle (Fig. 120, *d*) is too familiar to American gardeners to need description here. Its orange-colored eggs (*a*) are deposited in masses, varying in number from a dozen to fifty or more, on the under surface of the potato leaf, and occasionally also upon the leaves of grass, smartweed, or other plants in the potato field. They hatch about a week later into peculiar little grubs (*b*) that feed upon the foliage a few weeks. They then descend to the ground, where just beneath the soil surface, or under rubbish above it, they

change to pupæ (*c*). About ten days later they emerge as perfect beetles. There are from two to four annual broods, the number varying with the latitude, and the insect hibernates in the beetle state.

Like most other insects, the Colorado potato beetle fluctuates greatly in numbers and destructiveness. In any given locality it will be very destructive for a period



FIG. 120. COLORADO POTATO BEETLE. *a, a*, eggs; *b, b*, larvæ; *c*, pupa; *d, d*, beetles; *e*, wing of beetle, magnified.

of years, and then there may be several seasons when its injuries will hardly be noticed. This oscillation is probably due to the various natural enemies of the insect.

Remedies.—The standard remedy for this pest is that of spraying or dusting with some form of arsenic, such as London purple, Paris green, slug shot, etc. All of these take effect both upon the larvæ and beetles. London purple or Paris green may be dusted or sprayed on with a perforated can or a powder gun, or spraying machine. If used as a powder, the poison may well be diluted with several times its bulk of plaster, finely

sifted ashes, or flour. In spraying use six or seven ounces of London purple or Paris green to fifty gallons of water. For this purpose London purple seems preferable on account of its cheapness and finely powdered condition. The application should be made as soon as the beetles appear, in order to kill off the first brood, and it must be repeated as often during the season as is necessary to keep the pests in check. It is better to use the arsenite and Bordeaux mixture combination, thus preventing both beetles and blight. By many growers hand picking of the beetles and eggs, especially early in the season, is resorted to instead of the use of poisons. This method is effective if thoroughly carried out.

The Striped Blister Beetle

Epicauta vittata

This insect is sometimes called the old-fashioned potato beetle, because it was known as the "potato beetle" before the introduction of the more modern, as well as more destructive, Colorado species. It is a foe to the farmer only in its adult condition, for as a larva it feeds upon the eggs of various grasshoppers, forming one of the most efficient natural checks upon the increase of these pests. The adult blister beetle (Fig. 121) is a slender-bodied, rather long-legged insect, measuring from one-half to three-fourths of an inch in length, with alternate stripes of black and yellowish-brown upon the back. It feeds voraciously on the leaves of potatoes and various other vegetables. These beetles are generally gregarious, feeding in good-sized flocks, and when disturbed take to flight readily. The females deposit their small eggs in masses of a hundred or more, in the soil just below the surface.



FIG. 121.
STRIPED BLIS-
TER BEETLE.

In about ten days the eggs hatch into curious little larvæ that burrow through the earth in search of the eggs of grasshoppers. A large proportion of them probably perish because they can find none, but those that are successful feed upon the eggs and go through a curious series of changes, which have been admirably described by Dr. Riley, finally going into the pupal state and emerging later on as beetles. In the South there are apparently two broods each season. On account of the dependence of the larvæ upon grasshopper eggs, the beetles are much more likely to be destructively numerous during seasons following those in which grasshoppers have been abundant.

There are several other species of blister beetles with habits similar to this one, that are frequently found upon potatoes. The commonest is probably the black blister beetle (*Epicauta pennsylvanica*).

Remedies.—It is sometimes stated that these insects are not destroyed by eating Paris green, but this is probably a mistake. The application of this substance, however, seems often to be of no avail, probably either because it does not act immediately upon the beetles, or else because they continue to invade the field from the outside. A few years ago a favorite method of destroying them was to drive the flocks of beetles upon loose hay or straw spread upon the ground near where they are at work, and then burn the hay, lighting it at several different places, so that it will burn rapidly. Hand picking can often be resorted to advantageously. It is doubtful policy, however, to destroy these insects except when they threaten to do serious damage, because of the grasshopper-egg-feeding habits of the larvæ.

The Imbricated Snout Beetle

Epicærus imbricatus

This is a small beetle about half an inch long, silvery white in general color, with various darker markings upon its back. It feeds upon a great variety of vegetation, from the twigs and fruit of apple, cherry and gooseberry to the leaves and stems of onion, radish, melon, beans, beets, corn and potato. It often does very serious injury in the vegetable garden, but notwithstanding its commonness and destructiveness, its life history as yet has not been traced. Professor Forbes has found the eggs deposited between pear leaves fastened together, and Dr. Riley has conjectured that the larvæ will be found to feed externally on the roots of one or more of the food plants of the beetle. When alarmed the beetles feign death, resembling in this respect the plum curculio, and fall to the ground.

Remedies.—When these insects infest plants to which Paris green or London purple can safely be applied, the potato for example, they may easily be destroyed by such applications.

INSECTS AFFECTING CELERY, PARSNIP AND CARROT

INJURING THE LEAVES

The Celery Caterpillar

Papilio asterias

The life history of this insect has been discussed at some length in the Introduction (pages 5-7) in connection with Plate I, where its different stages are illustrated. The larvæ are handsome and quite conspicuous, and feed upon the foliage of the various members of the parsley family, including the carrot, celery, parsnip, etc., sometimes doing considerable injury when left unmolested. The caterpillars often become the victims of certain parasitic insects, but it is said that neither birds nor domestic fowls will eat them, probably because of the disagreeable odor emitted from the peculiar yellow horns situated on the body, just behind the head. The adult butterfly is one of the most beautiful as well as one of the commonest of its family.

Remedies.—When young these caterpillars may be destroyed by dusting them with insect powder or buhach. Ordinarily, however, they are not so abundant but that a little hand picking will readily hold them in check.

INSECTS AFFECTING THE SQUASH, MELON AND CUCUMBER

INJURING THE ROOTS

The Squash-vine Borer

Melittia ceto

The roots and stems of cucurbitaceous plants are frequently infested with a whitish larva that feeds upon the inner substance, often doing so serious a damage as to cause the plant to wilt and die. The parent of this squash-vine borer is one of the Aegerian moths. It is a handsome insect (Fig. 122), about half an inch long, with an orange-colored body ornamented by several black spots upon the back, and having olive-brown front wings and transparent hind ones. Eggs are deposited by this moth from the first of June until the middle of July, upon the stems of the young plants, often near the roots, and the larvæ resulting burrow into the center and feed upon the succulent interior. They remain here several weeks, gradually increasing in size. Toward the end of summer they become full-grown (*c*), when they measure about an inch in length, and are whitish with brown heads. They now leave the stem or root, and going into the ground an inch or two form cocoons by fastening particles of soil together with gummy silk. They then change to pupæ, and remain thus until the following season, when they emerge as moths. Occasionally in the North a moth emerges the same season, while in the South the insect appears to be normally two-brooded.

Remedies.—Professor J. B. Smith, who has studied this insect carefully, makes substantially the following recommendations, in growing squashes for market: (1) Fertilize heavily and evenly; not in the hills alone. (2) As early as may be plant summer squashes on the land to induce the moths to deposit eggs in them. A

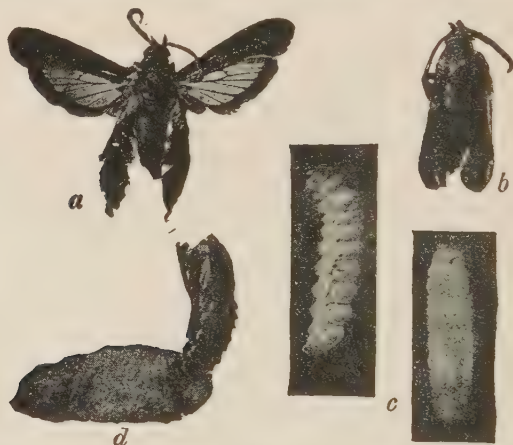


FIG. 122. SQUASH-VINE BORER. *a*, *b*, moth, wings expanded and at rest; *c*, larva, from side and from above; *d*, cocoon, from which pupa skin is extended. Natural size.

few rows in the field are sufficient, unless it is desired to produce a market crop. (3) Plant the Hubbards, marrowfats or other main crop as late as advisable without risking the crop, making the hills between those of the early varieties. (4) Keep a lookout for the moths, and when they are noticed, go over the field every evening during the twilight and kill all that are found sitting on the leaves. A little practice will enable one to cover three rows at one time without missing a specimen, and in less than an hour a large field can be cleared of moths. (5) When the late varieties need the ground, the crook-necks will have made at least a partial crop, even if

badly infested by borers, and the vines can be taken out and removed, leaving the ground to the later varieties. This should be done carefully, so that all the borers remain in the vines, and the latter should be thoroughly destroyed in some way that will kill all the contained larvæ. (6) As soon as the late vines begin to run well, they should be covered at the fourth joint, or even beyond it, and the ground should be kept in such condition that it can readily send down suckers from all the joints. This will enable it to resist injury and to ripen fruit even if it becomes infested by a few belated borers; *but there must be plant food enough where these joint roots are sent down, for that in the hill may be cut off.* (7) When the crop is made, the vines should be at once removed and destroyed, as were those of the summer squashes, so as to prevent the maturing of any borers then in them.

INJURING THE LEAVES

The Cucumber Flea-beetle

Crepidodera cucumeris

This is a small, blackish, punctate beetle about one-sixteenth of an inch long, with yellowish antennæ and legs, that appears early in spring, and as soon as the squash or cucumber plants are up, attacks them, eating off small, round patches of parenchyma from the upper surface of the leaves. Like all flea-beetles, they are quite active, hopping readily when disturbed. The larvæ are said to mine the leaves. The insect does not confine itself to squashes and cucumbers, but feeds upon a great variety of other plants.

Remedies.—Powdered tobacco has been found to be the best preventive of the injuries of flea-beetles. When used against the striped cucumber beetle, it will take effect upon the present pest as well.

The Squash Bug

Anasa tristis

The squash bug is too familiar to gardeners to need a detailed description here. It is a rusty-black, flattened bug, about half an inch long, with the underside ochre-yellow, and has a very repulsive "buggy" odor. This insect winters over as an adult, beneath boards, logs, leaves, or other protective covering, and appears in the squash patch late in spring or early in summer. The



FIG. 123.
SQUASH BUG.

females then deposit their brownish-yellow, spherical eggs on the undersides of the leaves in patches varying from three or four to a score or more. In a few days the young bugs, or nymphs, hatch, and insert their pointed beaks into the leaf and suck out the sap. At first they are more or less gregarious, the bugs from a single lot of eggs feeding together, but as they grow older they gradually disperse over the plants, casting their skins occasionally during their development. Like all true bugs, the transformations of this species are incomplete. The young bear a general resemblance to the adults, and the insect remains active in the stage corresponding to that of the pupa. Leaves attacked by the bugs become sickly and yellow, and if the pests are numerous the whole plant may finally be killed.

Remedies.—Hand picking appears to be the most practicable remedy that has yet been tried. This should be done during the cooler hours of the day, when the bugs are sluggish. The young may also be destroyed by spraying with kerosene emulsion. Professor Cook records good success in placing pieces of boards among the plants, under which the bugs collect at night, and where they may easily be found and destroyed. Mr. Benjamin Ware

reports good results from setting shingles in the soil at an angle of 45°. The bugs collect under these and are easily destroyed.

The Striped Cucumber Beetle

Diabrotica vittata

This is the small, yellow beetle (Fig. 124, *b*) with black stripes on its back, that so commonly attacks squashes, cucumbers, melons, and other cucurbitaceous plants, soon after they come up in the spring.

It feeds upon the leaves and stems, and in many parts of the country is so destructive that these plants cannot be grown unless preventive measures are taken to guard against its injuries.

The female beetles deposit eggs in the soil about the stems of the plants, and the larvæ resulting feed upon the roots. They reach maturity in a couple

of months, having pupated within the soil. The larvæ (Fig. 124, *a*) are whitish, cylindrical worms, not quite half an inch long, with three pairs of legs at the front of the body, and one pro-leg at the posterior extremity. The insect winters over in the beetle state, under leaves, logs, and rubbish of various kinds.

The beetles usually appear suddenly, often coming to the squash or melon field in great numbers within a

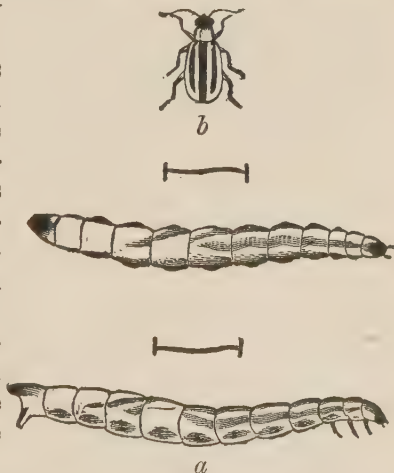


FIG. 124. CUCUMBER BEETLE. *a*, larva; *b*, beetle. Magnified.

few hours. Consequently a watch must be kept to prevent their doing damage before discovered.

Remedies.—There are probably few injurious insects for which more remedies and preventives have been suggested than for this. But a large proportion of these methods are worthless. Good success has been obtained by applying liberal quantities of refuse tobacco powder to the hills. A shovelful thrown upon the

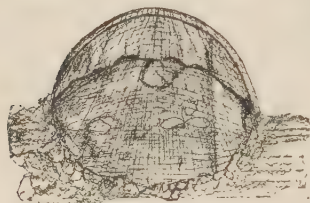


FIG. 125. VINE PROTECTOR.

hills has been found largely to prevent the damage. The application should be repeated occasionally, when wind and rain have removed the powder from the plants. The tobacco acts not only as a repellent to the beetles, but also as a mulch and fertilizer to the plants. Similar, though less liberal, applications of phosphates, bone dust, and other commercial fertilizers, are also recommended by some authorities.

For the kitchen garden the most satisfactory method is that of protecting the plants by some form of gauze netting. A simple method of doing this is illustrated at Fig. 125. The ends of half a barrel hoop are placed in the earth at the sides of the hill, and a square strip of thin plant cloth or cheese cloth is then laid over it, the cloth being drawn taut, and the edges covered with loose earth. This excludes the beetles, and at the same time permits access of air, moisture, and sunshine. Squash plants are able to grow until they get four or five leaves, and cucumbers and melons even more, before they are crippled by contact with the cloth. Wire may be substituted for the half barrel hoop. A single piece may be used, or two may be crossed like the center arch of a croquet ground, as represented at Fig. 126. Good results are also obtained by simply placing the cloth over the

plants without any support, and covering the edges as described. By loosening the cloth occasionally, the plant will lift it, and get several leaves before it need be removed. A modification of this method, which has been successfully used, consists of two end boards one-half inch thick, about fifteen inches long by six or eight inches wide. On the middle of each of these is nailed a piece of pointed lath at right angles to the long way of the board. The lower end of each lath projects below the edge of the board, and is stuck in the ground a few inches. Before the lath are put on, the end pieces are connected with each other by a piece of

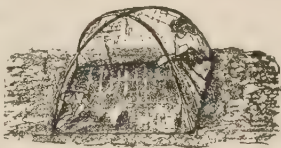


FIG. 126. VINE PROTECTOR.

plant cloth about 16x27 inches, the ends being tacked to the top and sides of the boards. This protector has many advantages. It can be stored in very little space. When it is desired to cultivate the hills, it is only necessary to pull up one end, stir the earth, and put the end back in position.

Gauze-covered wooden frames are sometimes recommended to prevent the injuries of this insect, but they are objectionable because they exclude a great deal of air and sunshine, causing the plants to grow tall and slender, rather than short and stocky.

The Twelve-spotted Cucumber Beetle

Diabrotica 12-punctata

This insect is similar in appearance and habits to the one treated of last, the adult having twelve black spots upon a yellow background, instead of being striped. The larva of this species bores the roots of corn and other plants. The remedial measures recommended above apply equally well to this insect. Its life history will be found more fully discussed on a later page, where it is treated of as the Southern corn-root worm.

INSECTS AFFECTING THE BEAN AND PEA

INJURING THE SEED

The Bean Weevil

Bruchus obtectus

One often finds beans with numbers of excavations in them, like those shown at Fig. 127, *b*. Such beans are affected by the bean weevil—an insect that is widely distributed over the United States, and often does very serious damage.

The adult weevil is represented natural size in the upper middle portion of Fig. 127, and enlarged at *a* of the same figure. It is a small, brownish insect that very much resembles the nearly related pea weevil. The eggs are deposited inside the pod, the mother beetle gnawing a narrow slit through the suture on the lower side of the pod and pushing her long ovipositor through this opening to lay a cluster of eggs inside. The beetle normally oviposits in green pods of good size. The eggs hatch in about a fortnight into larvæ which feed upon the beans for three or four weeks, when they pupate, and about ten days later emerge as adult beetles. These insects are also able to develop in dried beans, the various periods lasting longer in winter than in summer.



FIG. 127. BEAN WEEVIL. *a*, beetle, magnified; *b*, infested bean.

The larvæ gnaw out cells in the beans, several often occurring in a single bean, and are said at the time of pupation to leave the cells in which they have developed and to excavate another to pupate in. The adult beetles have been observed to feed upon the parenchyma of the growing plant.

Remedies.—Beans infested by these pests should be inclosed in tight vessels, into which a little bisulphide of carbon, benzine, or gasoline has been placed. The fumes of these volatile substances will destroy the beetles. Of course care must be taken that no particle of fire comes in the vicinity of the treatment. Late planting of the crop has been found a good way to prevent injury, by an extensive Illinois farmer living in the latitude of St. Louis, Missouri, who for a number of years has planted his field beans from June 20th to July 10th, with good results. If the beans, as soon as ripe, are heated to 145° Fahrenheit, the partially grown larvæ will be destroyed without injury to the germinating qualities of the seed. This will prevent much of the damage that would be done were the larvæ left to complete their growth.

The Pea Weevil

Bruchus pisi

As already stated, this insect is very similar to the bean weevil in life history and habits. The adult beetle deposits its yellow eggs on the outside of the young pods early in summer. On hatching, a few days later, the larvæ bore through the pods into the peas, which they enter and eat out the substance, leaving the radicle or germ untouched. On this account "buggy peas" will germinate, but as the young plants are deprived of the proper nourishment they make a less healthy growth

than do those resulting from uninjured peas. When full-grown the larva eats a hole on one side of the pea, leaving only the thin, outer covering, before entering the pupal state. Some time afterwards the insect again



FIG. 128. PEA WEEVIL. *a*, beetle, magnified; *b*, infested pea.

changes to the perfect beetle, a portion of which emerge the same season, but most of them remain in the peas until the following spring.

Remedies.—The measures mentioned as remedies for the bean weevil are equally applicable to this pest. That of heating the peas to 145° Fahrenheit as soon as gathered, seems especially advisable in the case of the pea weevil, for at the time of ripening a large proportion of the weevil larvæ are only partially grown.

INSECTS AFFECTING THE CABBAGE

INJURING THE ROOTS

The Cabbage-root Maggot

Phorbia brassicæ

The cabbage-root maggot is one of the most vexatious enemies of the gardener. The adult (Fig. 129, *c*) is a small, two-winged fly, somewhat like the common



FIG. 129. CABBAGE MAGGOT. *a*, larva; *b*, puparium; *c*, fly.

house fly in general appearance, which appears in the cabbage field soon after the plants are set out, and deposits its eggs about the stems at the soil surface. The little, whitish maggots soon hatch, and work their way downward to the roots, which they attack, feeding upon the outer surface and thus making grooves, or boring into the interior and hollowing out cavities. They sometimes cause the roots to thicken up and become malformed, producing an effect similar to that of the fungus causing the disease known as "club root." In two or three weeks the maggots become full-fed (*a*), and

they change to the pupal state within hard brown puparia (*b*), to emerge fifteen or twenty days afterward as adult flies. There are probably two or three broods each season, and the insect apparently hibernates in each of its three later stages. These insects infest turnips, rutabagas and radishes, as well as the cabbage, and also breed in wild cruciferous plants.

Remedies.—A large number of unsatisfactory remedies have been proposed for this insect. In some cases



FIG. 130. CABBAGE ROOTS INJURED BY MAGGOTS.

immunity from attack may be had by planting the crop each year a considerable distance from where it was before, although the fact that the insect breeds in wild cruciferous plants sometimes causes the insects to attack cabbages on land not previously planted to this crop. In special cases where only a few cabbages or radishes are to be raised, the flies can be kept out by growing in cold frames covered with cheese cloth or fine netting.

The most satisfactory preventive method that has been used on a large scale is that of protecting the plants by tarred paper (one-ply tarred felt) cards, in a way similar to that shown in *a*, Fig. 131. The method of making and applying these cards is described by Professor Goff as follows: "The cards are cut in a hexagonal form, in order to better economize the material, and a thinner grade of tarred paper than the ordinary



FIG. 131. TARRED PAPER CARDS ON BASE OF PLANTS. *a*, correctly put on; *b*, carelessly put on.

roofing felt is used, as it is not only cheaper, but being more flexible, the cards made from it are more readily placed about the plant without being torn.

"The blade of the tool, which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center, as shown in Fig. 132. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the

handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect and that its outline represents an exact half hexagon.

"To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, as indicated in Fig. 132, using only one angle of the tool. Then commence at the left side, place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used.*

"The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly, to open the slit, then slip it on to the center, the stem entering the slit, after which spread the card out flat, and press the points formed by the star-shaped cut snugly around the stem." At *a*, in Fig. 131, is shown a card properly applied to the stem of a geranium; *b* shows a card carelessly put on.

Another way of preventing the injuries of the cabbage-root maggot is by the use of a carbolic acid emulsion. Mr. Slingerland recommends that it be made by the following formula: "One pound of hard soap or one quart of soft soap dissolved in one gallon of boiling water, into which one pint of *crude* carbolic acid is then poured and the whole mass agitated into an emulsion, which

*It is stated that these cutting tools can be bought of P. J. Diepold, Madison, Wis., for \$2.50 each.

will remain in this condition for a long time. In treating the plants, take one part of this standard emulsion and dilute it with thirty equal parts of water; it probably can be used stronger without injury to the plants. If the emulsion is cold and semi-solid use several parts

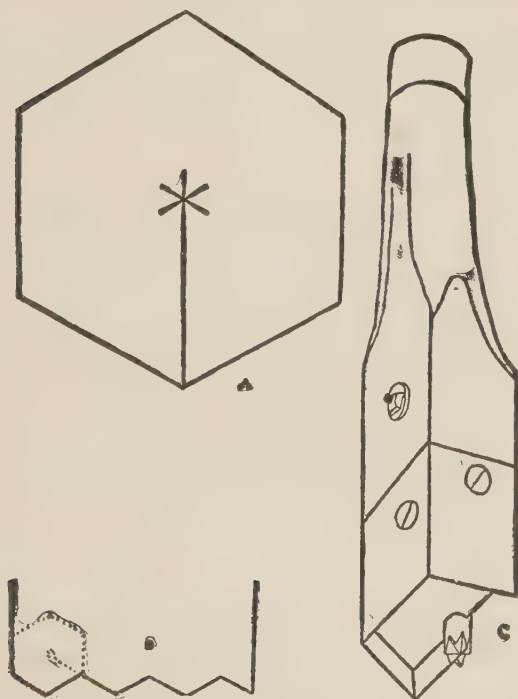


FIG. 132. *a*, outline of paper card, two-thirds natural size; *b*, diagram showing how tool is used; dotted line shows position of edge of tool; *c*, tool for cutting cards (reduced).

of warm water at first. Begin the treatment early, a day or two after the plants are up, or in the case of cabbages and cauliflowers, the next day after they are set in the field, and repeat it once each week or ten days until about

May 20 in New York. While we have little faith in the preventive effects of the early treatments, we do believe that the emulsion will then kill many of the eggs and recently hatched maggots. If it could be applied with some force through a syringe or force pump, it might not be necessary to go to this trouble of first removing some of the earth from about the plants. It must be remembered that its success will depend on the eggs or maggots being hit with it. None of the cabbages in our experiment were injured in the least by an application containing nearly twice as much of the acid, and there is but little danger of its injuring the tenderest foliage of radishes, turnips or onions; if any injury manifests itself on these crops, dilute the emulsion with forty or fifty or more parts of water, instead of thirty. A knapsack or a wheelbarrow sprayer would prove a very useful instrument in applying the emulsion on a large scale."

The use of carbon bisulphide, applied with a specially devised injector, has also given good results. For an account of this and other remedial methods the reader is referred to Bulletin 78 of the Cornell University Experiment Station. In some localities the growers search regularly about the bases of the stems for the bunches of whitish eggs, and claim it to be the best method of checking the injuries of the pest.

INJURING THE LEAVES

The Imported Cabbage Worm

Pieris rapæ

This insect was imported into America from Europe about 1857, since when it has become exceedingly destructive over a large portion of the United States and Canada. The adult is a common white butterfly, the female of which has two black spots upon each of the front wings (Fig. 133, *c*), while the male (Fig. 134) has but one

The former deposits, singly or in clusters of two or three each, small, fusiform, yellowish eggs upon the cabbage leaves, which soon hatch into little, green larvæ that feed upon the substance of the foliage. In about two weeks they become full-grown (Fig. 133, *a*), when they generally leave the cabbage plants, and, finding some suitable shelter—beneath a board or under the coping of a fence—change to chrysalids (Fig. 133, *b*). They remain in this condition about ten days, when they emerge as but-



FIG. 133. IMPORTED CABBAGE WORM: *a*, larva; *b*, chrysalis; *c*, female butterfly.

terflies, to lay eggs for another brood of worms. The winter is passed in the chrysalis state. There are several generations of larvæ each season, the number varying with the climate and latitude.

This insect has numerous natural enemies with which to contend. The larvæ and pupæ are preyed upon by certain parasitic and predaceous insects, and the butterflies are often captured by insectivorous birds, as well as by a predaceous bug known to entomologists as *Phymata wolffii*. The larvæ are often destroyed by thousands by a bacterial disease—a sort of insect cholera—that has lately aided greatly in checking the injuries of this pest.

There are two or three species of native cabbage worms—notably the Southern cabbage butterfly (*Pieris protodice*) and the pot-herb butterfly (*P. oleracea*) closely related and similar to this imported worm, that were formerly quite injurious to cabbage, but since the introduction of the alien species they have been largely crowded to the wall, and are seldom destructive.

Remedies.—Pyrethrum (insect powder or buhach), hot water and kerosene emulsion are the substances that can most successfully be used in fighting the imported cabbage worm. The



FIG. 134. IMPORTED CABBAGE BUTTERFLY. Male.

insect powder may be diluted with six or eight times its bulk of flour, and dusted on with a powder gun or bellows, or it may be mixed with water in the proportion of one ounce to four or five gallons of water, and sprayed upon the plants. Dr. Riley gives preference to hot water as a remedy for this insect. He states that "every worm visible upon the cabbages may be killed by the use of hot water at the temperature of 130° Fahrenheit. The water may be boiling hot when put in the watering can, but it will not be too hot when it reaches the cabbage leaves." Kerosene emulsion can advantageously be used when the plants are young, though there would appear to be danger of tainting the heads if applied to the fully developed plants. Whichever method of treatment is adopted, it should be carried into practice at frequent intervals, thus keeping the worms well in check. If the plants are dusted with insect powder once a week during the time that the worms are present, they will cause little or no trouble.

The Cabbage Plusia

Plusia brassicæ

This insect, illustrated in its three later stages at Fig. 135, has been known for years to do serious injury to a number of garden crops. While it is especially injurious to cabbage, it also attacks celery, turnip, tomato, clover, cauliflower, lettuce, dandelion, dock, and several other plants. The adult (shown at upper part of Fig. 135) is a handsome, dark-gray moth, with a silvery spot near the middle of each front wing. The females deposit their pale, greenish-yellow eggs singly or in clusters, on



FIG. 135. CABBAGE PLUSIA. *a*, larva; *b*, pupa in cocoon; *c*, moth.

the cabbage leaves, usually on the upper surface. The larvæ soon hatch and devour the leaves as they develop, boring small, irregular holes in the cabbage head. When full-grown (*a*) they are about an inch long, of a general pale-green color, with longitudinal lighter stripes; the head is small, and the body gradually enlarges from the front backward. In motion the body assumes a looping position, as shown in the figure. The full-grown larva

spins a slight, white, silken cocoon on the cabbage leaf, generally on the lower surface, and within this changes to a brownish pupa (*b*). In a short time it emerges as a moth. At the South, where this insect is ordinarily more destructive than at the North, there are several broods each season. The moths are nocturnal or crepuscular, but in cloudy weather are sometimes seen flying during the day.

The larvæ of the cabbage plusia are subject to the attacks of many enemies; they are devoured by birds, destroyed by certain parasitic insects, and often become the victims of a fungous disease.

Remedies.—This insect is more difficult to destroy than the imported cabbage worm, but it will succumb to pyrethrum if not diluted with more than three times its bulk of flour, and may also be killed with the kerosene emulsion applied in a spray.

The Zebra Caterpillar

Ceramica picta

This caterpillar is at once distinguished from other larvæ feeding upon cabbage by the brilliant yellow and black markings upon its body. It originates from small, spherical eggs, laid in clusters upon the cabbage leaves by a handsome, purplish-brown moth (Fig. 136, *b*), that appears early in summer. At first the larvæ are very dark, and feed together gregariously, but as they develop they become lighter colored, and disperse over the plant. When disturbed they roll up and drop to the ground. They become full-grown (*a*) in three or four weeks, when they are about two inches long, with a wide, longitudinal, velvet-black stripe upon the middle of the back, and two bright yellow stripes upon each side, which are connected by fine, yellow, transverse lines. The caterpillars now construct, slightly beneath the soil surface,

loose cocoons composed of particles of earth fastened together by silken threads, within which they change to pupæ. About a fortnight later the moths emerge, and deposit eggs for a second brood of larvæ, which develop early in autumn, pupating before winter, and hibernating within their cocoons.



FIG. 136. ZEBRA CATERPILLAR. *a*, larva; *b*, moth.

Remedies.—When young the larvæ are congregated together upon one or a few leaves, and may then easily be checked by hand picking. Later they are open to destruction by the application of hot water, insect powder, or kerosene emulsion.

The Wavy-striped Flea-beetle

Phyllotreta vittata

This little pest does not by any means confine its depredations to the cabbage, but attacks turnip, mustard, radish, and various other plants as well. It is represented in Fig. 137, *a*, and is a small, shining black beetle, one-tenth of an inch long, with a broad, yellow,

wavy, longitudinal stripe on each wing cover. It feeds upon the surface of the leaf, gnawing out little pits. The females deposit their minute, oval, whitish eggs upon the roots of various cruciferous plants, such as radish, cabbage, turnip, etc., and the larvæ which hatch



FIG. 137. WAVY-STRIPED FLEA-BEETLE. *a*, beetle; *b*, larva; *c*, pupa.

from them feed upon these roots, sometimes doing serious damage in this way. The full-grown larva (*b*) is about one-fourth of an inch long, with a yellowish-white body, and brown head. There appear to be two or more broods each season.

Remedies.—Tobacco powder is the best remedy for these little pests. If applied freely to the plants, it will drive them away. In seasons when the beetles are not too thick, dusting the plants with dry, unleached wood ashes, or lime or plaster, will also keep them off, and tobacco decoction is a good remedy.

Cabbage Cutworms

The cabbage is subject to attack by nearly a dozen species of cutworms, nearly all of which, however, are similar in habits and history, and may well be treated or collectively. They are all larvæ of medium-sized, night-flying moths, and are rather thick, naked worms of the general form of Fig. 138, *a*. They curl up when disturbed. The eggs are deposited generally on the branches of trees and shrubs, the larvæ descending to the ground in search of food as soon as hatched. Most of them feed upon grass or clover when young, becoming about half-grown by winter time, when they seek the shelter of some log or stone, or burrow into the soil. Here they hibernate, and in spring come forth in search of food. They now attack a variety of young plants,

biting off the stems and feeding upon the leaves. Cabbages, tomatoes, turnips, squashes, melons, and various other garden vegetables are all liable to their attacks. They become full-grown in spring or early summer, when they pupate beneath the soil surface, and three or four weeks later emerge as moths. The larva (*a*) and moth (*b*) of the variegated cutworm (*Agrotis saucia*) are represented, natural size, at Fig. 138. Some species have two or more broods each season, while others have but one. Cutworms are especially likely to do damage in fields and gardens close to grass lands, and to crops immediately following grass. †



FIG. 138. VARIEGATED CUTWORM.
a, larva; *b*, moth.

Remedies.—Of the dozens of methods of destroying cutworms, there are three which are of special merit. They are :

(1). *The poison method.* This consists in killing off the worms before the crops are planted, by strewing over the soil bunches of fresh clover or cabbage leaves, which have been treated with Paris green or London purple, either by dipping into a solution of the poison, or dusting it on dry. The half-grown worms prowling about in search of food eat of the baits thus set, and are destroyed before doing any harm. This method has proved a practical success with many gardeners, and is well worth trying where there is likely to be trouble from these pests. Of course care must be taken that chickens or stock do not get at the poisoned leaves.

(2). *Using boards as traps.* This method consists in placing boards on the ground in and about the gar-

den, and collecting in the morning the worms that will congregate beneath them during the night.

(3) *Digging out the worms* where plants have been cut off. This is practicable in most gardens, and is well worth doing, thus preventing further damage.

The Harlequin Cabbage Bug

Murgantia histrionica

The injuries of this insect were first noticed in Texas and other States at the far South, but it has gradually spread northward, especially along the Atlantic coast, until now it is seriously injurious as far north as

Delaware. It feeds upon a variety of cruciferous plants, including cabbage, radish, mustard, turnip, etc.

The insect "derives its name from the gay, theatrical, harlequin-like manner in which the black and orange-yellow colors are arranged upon its body"

(Fig. 139, *a*, *b*, *f*, *g*). According to Dr. G. Lincecum, in Texas, "the perfect insect lives through the winter, and is ready to deposit its eggs as early as the 15th of March, or sooner if it finds any cruciform plant large enough. They set their eggs (*c*, *d*, *e*) on end in two rows, cemented together, mostly on the under-side of the leaf, and generally from eleven to twelve in number. In about six days in April (four days in July) there hatches out from these eggs a brood of larvæ, resembling the perfect insect, except in having no wings.

FIG. 139. HARLEQUIN CABBAGE BUG. *a*, *b*, nymphs; *c*, eggs; *f*, adult; *g*, adult with wings extended—all natural size; *d*, eggs, side view; *e*, eggs, view from above,—*d*, *e*, enlarged.

This brood immediately begins the work of destruction by piercing and sucking the life sap from the leaves, and in twelve days they have matured. They are timid, and run off and hide behind the first leaf stem, or any part of the plant that will answer the purpose. The leaf that they puncture soon wilts, like the effects of poison, and soon withers. Half a dozen grown insects will kill a cabbage in a day." At the South there are several broods each season.

Remedies.—According to Mr. Howard Evarts Weed of the Mississippi Experiment Station, "there is but one efficient remedy for this insect, which is, to destroy the brood which lives over winter, when they congregate upon the mustard or radish plants. Here they can be destroyed very easily by the application of kerosene (not emulsified) by means of a hand force pump or common watering bucket. If the insects are thus destroyed early in the season, it will almost wholly prevent injury later. The insects fly but little, and are thus not apt to come from a neighboring field." Those bugs or eggs which may be seen on cabbage, should be picked off and destroyed. Clean cultivation and the burning of all rubbish are important preventive measures. In spring and autumn many of the bugs may be trapped by laying cabbage or turnip leaves between the rows: the insects will harbor under these, and may be collected each morning. It is especially important to destroy the earlier broods of this pest, because otherwise it increases so rapidly as to be almost unconquerable.

The Cabbage Aphis

Aphis brassicæ

Next to the imported cabbage worm this species is, perhaps, the most injurious insect enemy of the cabbage; and it also infests various other cruciferous plants, including turnip, radish, field cress, and shepherd's purse. It appears to have been originally a European species,

and was probably introduced into America at an early date. It is probable that it is now found in this country wherever the cabbage is extensively grown.

The cabbage aphid is a small, greenish insect, generally covered with a whitish, mealy coating, that occurs

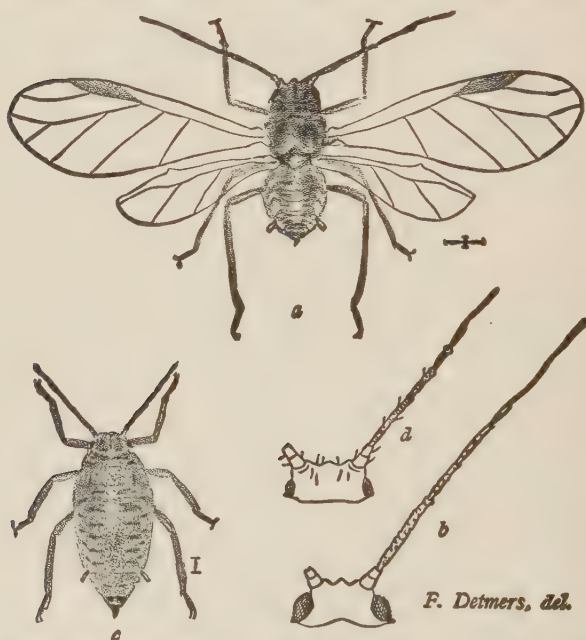


FIG. 140. CABBAGE APHIS. *a*, male; *b*, head and antenna of same; *c*, female; *d*, head and antenna. Magnified.

in great numbers on the leaves and in the heads. During the summer months it reproduces viviparously, but in autumn true males and females (Fig. 140) are developed, eggs being deposited by the latter upon the cabbage leaves. Except in the North the insect winters over in the adult condition.

Remedies.—Kerosene emulsion is the most effective insecticide that can be used against this insect.

INSECTS AFFECTING THE ONION

INJURING THE BULBS

The Onion Maggot

Phorbia ceparum

The onion maggot is closely related to the cabbage maggot, to which it is similar in life history and habits. The adult is a two-winged fly, which deposits its small white eggs on the bulbs or lower leaves of the young plants. About a week later the eggs hatch into young larvæ that bore into the bulbs, absorbing the succulent substance. When one bulb is consumed they pass on to another. The full-grown larvæ are nearly half an inch long, of a dull white color, and pointed at the mouth or front end. They complete their larval growth in about two weeks, and then leave the onions and enter the surrounding earth, where they change to the pupal state within brown puparia. A fortnight later the flies emerge to lay eggs for another brood.

Remedies.—Professor Cook states that the most practical method of preventing the injuries of this insect is to change the position of the onion bed every year, putting it each time some distance from where it was the preceding season. Wherever the conditions are such that this can be done, this is probably the best preventive measure. Miss Ormerod reports that in England, if the bulbs are kept covered with earth, they are not attacked by the maggots. Mr. J. J. H. Gregory says that the best remedy is “a hen and chickens.

Allowing a couple of broods to an acre, confine the hen in a small coop near the middle of the piece, and give the chickens free exit. They will soon learn to catch the fly while in the act of laying the egg which produces the maggot." The insecticides recommended for the cabbage maggot may also be used for this pest.

INSECTS AFFECTING ASPARAGUS

The Asparagus Beetle

Crioceris asparagi

This insect was introduced into America from Europe about thirty years ago, and at once became very destructive to asparagus in the region of New York city. It has since spread over a large area, being reported in 1890 as far west as Ohio. According to Professor Comstock its life history may be briefly summarized as follows: "Upon the appearance of the plants in early spring, and just before the cultivators are ready to begin bunching for the early market, the beetles come forth in great numbers from their hibernating quarters—under sticks, stones, rubbish, and especially under the splinters of wood on fences and under the scaly bark of trees—and commence gnawing the tops of the young plants. They pair and lay their eggs very soon. The eggs (Fig. 141, *a*) are oval and are placed endwise on the plant, usually in rows of two to seven. In from seven to ten days the young larvæ begin to make their appearance. In form they bear a close resemblance to the Colorado potato-beetle larvæ. The general color is grayish olive



FIG. 141. ASPARAGUS BEETLE. *a*, eggs on stalk; *b*, larva; *c*, beetle; *b* and *c* magnified.

with shining black head and brown legs. When full-grown (*b*) they measure a little over three-tenths of an inch." The larvæ feed upon the outer bark of the asparagus, and develop in about two weeks from the time of hatching. They then descend to the earth where, slightly beneath the surface, or under rubbish above the surface, they change to pupæ. About ten days later they emerge as beetles to feed upon the plants and deposit eggs for another brood. The beetles (*c*) are very pretty little creatures, with head, legs and antennæ of a shining metallic greenish-black hue, a reddish-brown thorax ornamented with two conspicuous black spots, and lemon-yellow wing covers, marked with a longitudinal black stripe and a transverse black band. There are two or more broods each season.

Remedies.—The plan most successfully adopted by Long Island gardeners to prevent the injuries of this insect is that of destroying, by hoeing or other cultivation, all volunteer growth of asparagus, leaving only the shoots designed for market for the beetles to lay their eggs upon. These shoots are cut and removed so often that there is no opportunity for the eggs to hatch in the field, and thus the increase of the pest is effectually prevented. The beetles are greedily devoured by domestic fowls, and in kitchen gardens these can sometimes be advantageously used against them. Of the artificial insecticides, pyrethrum will probably give the best results. In small patches it has been found practicable to rub off the eggs from the growing shoots.

PART V

INSECTS AFFECTING CEREAL AND FORAGE CROPS



PLATE XIV. THE STRIPED HARVEST SPIDER.

INSECTS AFFECTING INDIAN CORN

INJURING THE ROOT

The Corn-root Aphis

Aphis maidi-radici

This is a small, bluish-green aphis, or louse, which occurs on the roots of corn, from the time it comes up in spring until it is cut in autumn. Its general form, when magnified, is well shown at Fig. 142, which represents a closely related species, the apple aphis. There are two forms found upon the roots, one having wings and the other not, the latter being much the commonest. Both forms are always attended by the common, small brown ant (*Lasius alienus*), which cares for them as tenderly as it does for the eggs and young of its own species. Eggs are laid by the aphides during September and October, in the subterranean galleries of the ants, and are collected by the latter and cared for all winter. In spring, when the lice are beginning to hatch, the ants tunnel about the roots of corn, or various weedy plants, and transport the little aphides to them. The lice feed upon the sap of the plant, sucking it through their tiny beaks, and multiply viviparously, or by giving birth to living young. They continue devel-



FIG. 142. APPLE APHIS. Magnified.

oping in this way until fall, when the egg-laying brood is produced.

The presence of these lice upon the roots can easily be determined by carefully pulling or digging up plants supposed to be injured. The aphides, if present, will be seen crowding the roots as small, bluish-green particles. The affected plants generally appear yellow and sickly, growing slowly or not at all.

Remedies. — Professor Forbes summarizes the economic results of years of study of this pest by recommending :“(1) That the fertility of the ground should be maintained as a general safeguard, and that cultivation should be so managed—especially that of the lower parts of the field—so as to prevent so far as practicable the seeding of pigeon grass and smartweed among corn ; (2) that infested fields should be plowed deeply and thoroughly, harrowed late in fall or during some suitable early winter interval ; and (3) that a somewhat rapid rotation of crops should be systematically followed, corn usually being allowed to grow on the same ground but two years in succession.”

The Northern Corn-root Worm

Diabrotica longicornis

In Illinois, Kansas and other Western States, the roots of corn are frequently eaten off, during June and July, by a slender white worm, a little less than half an inch long, and about as thick as a common pin. It has a small, brown head, and three pairs of short legs near the front end, as shown at Fig. 143, *c*. It attacks the roots from the outer ends, burrowing beneath the surface, and eating its way toward the stalk. Shortly after midsummer it becomes full-fed, and deserting the root, pupates in the surrounding soil. The pupa (*d*) is about one-fifth of an inch long, and white in color. A

few days later it again transforms, and emerges as a grass-green beetle of the form represented at Fig. 143, *e*. "The beetle climbs up the stalk," according to Professor Forbes's account, "living upon fallen pollen, and upon the silk at the top of the ear, until the latter dries, when a few of the beetles creep down between the husks and feed upon the corn itself, while the others resort for food to the pollen of such weeds in the field as are at that time in blossom. In September and October the eggs (*a*) are laid in the ground, upon or about the roots of the corn, and most of the beetles soon after dis-

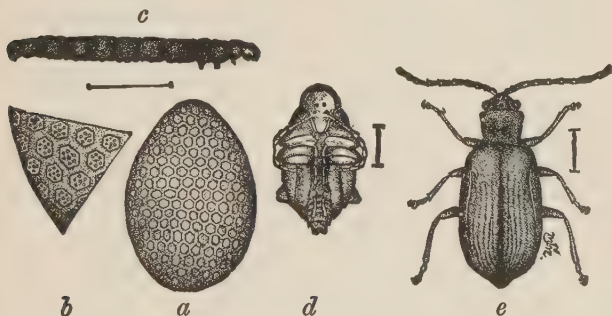


FIG. 143. CORN-ROOT WORM. *a*, egg; *b*, small section of egg, greatly magnified; *c*, larva; *d*, pupa; *e*, beetle. Magnified.

appear from the field." They feed for awhile upon various fall flowers and gradually die off, the winter being passed by means of the eggs deposited in the corn ground. The eggs hatch the following spring.

Remedies.—As the eggs of this insect are deposited in autumn in corn ground, rotation of crops furnishes a simple method of preventing its injuries. If the land is planted to some other crop the year following, the larvæ, on hatching, will be deprived of suitable food, and consequently will perish.

The Southern Corn-root Worm

Diabrotica 12-punctata

The four later stages of this insect are represented at Fig. 144. The larva (*b*) is a slender, whitish worm, about half an inch long, resembling the Northern corn-root worm, to which in fact it is closely related. It feeds promiscuously upon the roots and base of the stalk

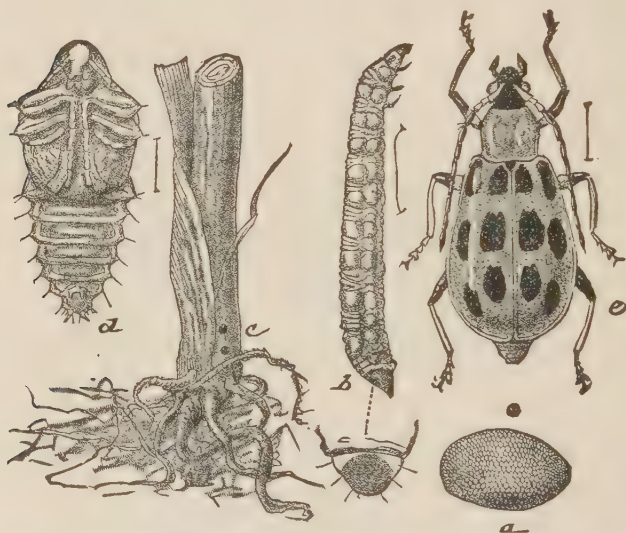


FIG. 144. SOUTHERN CORN-ROOT WORM. *a*, egg; *b*, larva; *c*, corn stalk showing punctures; *d*, pupa; *e*, beetle. All but *c* magnified.

of corn, pupating in the soil about the roots, and emerging shortly afterwards as a yellow beetle with twelve black spots upon the back (*e*). There are two broods each season, eggs for the first brood being deposited by the female beetles in spring about the roots of young corn, and the second brood of larvæ generally developing upon the roots of certain wild plants, especially those of the Composite family. The insect hibernates as an

adult, and the beetles feed upon a great variety of vegetation, often doing serious damage to cucumbers, squashes, melons, and other garden vegetables.

Remedies.—No practicable remedy has yet been found for this insect in its corn-infesting stage.

Wireworms

Elateridæ

Sprouting kernels of corn are often attacked by a hard, slender, yellowish worm, commonly called the wireworm, which eats out the substance of the seed or attacks the young roots. These are the young or larvæ of various species of brown, flattened, elongate beetles, called click beetles, snapping bugs, or "skipjacks," on account of their habit of snapping upward in the air when placed on their backs. Eggs are laid by these beetles in grass lands especially, and the larvæ that hatch feed, presumably for two years, upon the roots of various plants. They finally transform during autumn in hollow cells in the earth into pupæ, and shortly afterwards again change to beetles. They do not all however, leave their pupa cells at once, but many remain in them until the following spring. Professor J. H. Comstock has found that in breeding cages, if these cells be broken open in the fall, the beetles die.

Remedies.—On account of the fact just mentioned, fall plowing has been recommended as a preventive of wireworm injury, the supposition being that the cells in which the beetles are resting will thus be broken open and the insects perish. A rotation by which clover will

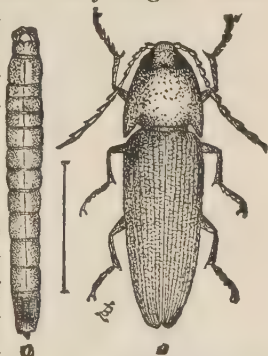


FIG. 145. WIREWORM AND CLICK BEETLE.

come in between grass and corn is suggested as the best way of preventing injury in cornfields.

INJURING THE STALK AND LEAVES

The Stalk Borer

Gortyna nitela

The terminal leaves of growing corn plants are sometimes observed suddenly to wilt and wither. If pulled upward it will be seen that they have been cut off inside the stalk, where there will generally be found a striped,



FIG. 146. STALK BORER. 1, moth; 2, larva.

brown worm, of the form represented at Fig. 146, 2. This is the stalk borer, so called because of its habit of burrowing the stalks of various plants, such as the potato, tomato, cocklebur, etc. It hatches from an egg laid by a brown moth (1), and pupates beneath the soil surface. The moths appear late in summer or early in autumn, and the insect apparently hibernates in its adult condition.

Remedies.—The only general measure that can be recommended against this insect is that of clean farming. The species largely develops in wayside weeds, and consequently these should be destroyed. Wherever the larvæ are found at work they should, of course, be killed.

Cutworms

Noctuidæ

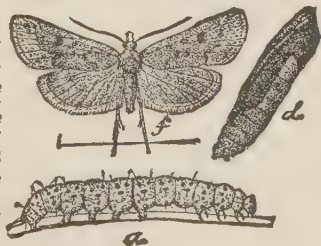
The general life history of the various species of cutworms has already been described on Page 256. These pests are especially liable to injure corn planted on sod land, but such damage may easily be prevented by using the poison traps described in connection with remedies for cabbage cutworms (p. 257). The field to be planted should be strewn with poisoned clover or grass, or cabbage leaves, before the crop is put in, although if not done then the baits may be placed between the rows afterwards.

The Garden Webworm

Eurycreon rantis

This insect occasionally becomes destructive over a wide area, and damages a great variety of crops, although corn usually suffers most.

The adult is a small grayish moth (Fig. 147, *f*), expanding about three-quarters of an inch, the females of which deposit their eggs upon the leaves or stems of various plants. Soon after hatching the young larvæ begin to spin a protective



web, which is enlarged as the insects develop. Beneath this they feed upon the foliage, eating at first only the surface substance, but as they grow older they devour the whole leaf. The larvæ become full-grown in about a fortnight, when they spin thin, brownish cocoons on the ground, and change to

FIG. 147. GARDEN WEBWORM. *a*, larva; *d*, pupa, both twice natural size; *f*, moth, slightly enlarged.

pupæ, to emerge ten days or two weeks later as moths. There are two or three broods each season.

Remedies.—Spraying or dusting infested plants with London purple or Paris green is the most practical remedy for this insect that has yet been suggested.

The Corn-leaf Aphis

Aphis maidis

The leaves and stalks of corn are often infested by colonies of a small bluish aphis or plant louse, the majority of which are wingless and the rest winged. This is the corn aphis. It has been for a long while considered the aerial form of the corn-root louse, but the latest investigations indicate that the two are distinct species.

The full life history of this insect is not known. It is probably the summer form of some species that passes the fall, winter and spring upon a tree or shrub. The winged viviparous females appear upon the corn early in summer and start colonies of young lice which develop rapidly and continue to multiply viviparously until the approach of cold weather in autumn. Then a winged brood appears and leaves the corn, migrating, doubtless, to some other plant. But where it goes, and where the winged females that start the colonies in early summer come from, is not known.

These plant lice have many natural enemies with which to contend. Chief among these are certain minute four-winged parasitic flies, the lady beetles and the harvest spiders or daddy longlegs. The first-named of these enemies are true parasites, developing within the bodies of the aphides, but the rest are predaceous insects. There are several species of lady beetles that, both in their larval and adult states, prey upon the corn aphis. It is probable, also, that great numbers of the aphides are destroyed by the harvest spiders which abound upon

corn plants during summer. One of the commonest of these—the striped harvest spider—is shown, natural size, at Plate XIV.

Remedies.—It seldom becomes necessary to resort to artificial remedies for this insect. While it could readily be destroyed with kerosene emulsion, the application generally would not pay in field culture.

INJURING THE EARS

The Corn Worm or Bollworm

Heliothis armigera

In the Southern States this insect is called the bollworm because it feeds upon cotton bolls; but at the

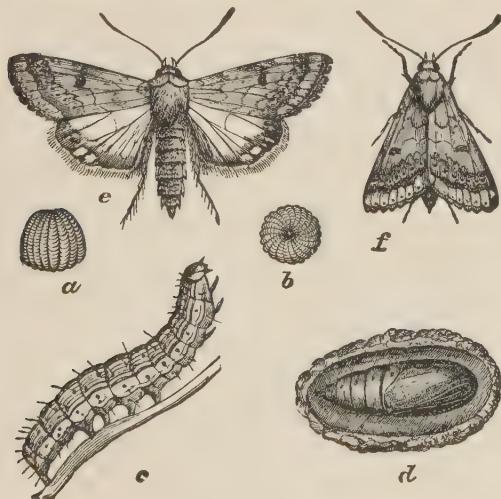


FIG. 148. CORN WORM. *a*, *b*, eggs, side view and top view, magnified; *c*, larva; *d*, pupa, in cocoon; *e*, moth with wings expanded; *f*, moth with wings closed.

North it is known as the corn worm from its habit of eating the kernels of ripening corn. On this account it has come to be recognized as one of the most vexatious



PLATE XV. CORN INJURED BY CORN WORM.

insect enemies of this crop, and no thoroughgoing remedy that is practicable on a large scale has as yet been devised for it. The parent is a good-sized, greenish-yellow moth (Fig. 148 *e*, *f*) with a conspicuous black spot near the middle of the front wings, and various olive or rufous markings. These insects deposit their eggs among the silks of the young ears. The larvæ soon hatch and eat through the husk to the succulent kernels beneath, which they devour greedily for several weeks, gnawing irregular channels along the cob (Plate XV). When full-grown (148, *c*) they are an inch and a half long, of a pale green or dark brown color, ornamented with longitudinal darker stripes. They now leave the ear, and, entering the soil a few inches, form loose cocoons of silk with particles of soil intermixed, within which they change to chestnut-brown pupæ (148, *d*), emerging about a fortnight later as moths. At the North there are two broods, a third one occasionally developing in exceptionally long seasons, while at the South there are four or five. The first brood is especially likely to infest early sweet corn in gardens.

Remedies.—Hand picking is the only remedy that has been suggested, except that of catching the moths by light traps. The silk of infested ears shows the presence of the larvæ by being prematurely dry or partially eaten, and the larvæ may be readily found and crushed. In garden patches of sweet corn, at least, this method is worth using. In fields, fall plowing will help to reduce the amount of damage by destroying the pupæ, either directly or indirectly, by exposing them to the weather and birds.

INSECTS AFFECTING WHEAT

INJURING THE STALK AND LEAF

The Hessian Fly

Cecidomyia destructor

This is one of the oldest and best-known insect pests of American agriculture. It has ranked as a destructive species for more than a century, and has probably been



FIG. 149. HESSIAN FLY. *a*, larva; *b*, pupa; *c*, injured stem; *d*, fly.

introduced nearly everywhere that wheat is grown. The adult is a small, two-winged, mosquito-like fly (Fig. 149, *d*), the females of which deposit their eggs on the upper surfaces of the wheat blades early in autumn. In a few days the larvæ hatch, and

each descends the leaf to the base of the sheath, where it attaches itself, head downwards, to the stalk, and proceeds to absorb the life sap of the plant. As the latter grows the young larva becomes imbedded in the stalk, where it remains stationary. When full-grown (which occurs in three or four weeks from the time of hatching) the larva is a soft, white, footless maggot of the form represented at *a*. Its outer skin now becomes hard and brown, and separates from the rest of the body,

although it still surrounds the latter, forming a sort of cocoon, or, as it is more correctly called, puparium within which the insect changes to a pupa (*b*). This is the "flaxseed" state, so called because of the resemblance of these brown puparia to flaxseeds. The winter is usually passed in this condition, and in spring the flies emerge from the flaxseeds to lay eggs for another brood. The larvæ of the fall brood affect the young wheat plants just above the roots, between the stalk and sheathing base of the leaf, but the spring generation are formed a little higher up, at the joints an inch or more above the soil surface. This second generation completes its transformations before harvest, and there is often, if not always, at least as far north as the latitude of 40° , a third brood, which develops during summer in volunteer wheat; and Professor Forbes has shown that there may occasionally be even a fourth brood during the year. But the chief damage is done by the fall and spring broods.

There are several species of insect parasites which attack the Hessian fly, so checking it that in most localities it only occasionally becomes injurious.

Remedies.—The most promising method of preventing the injuries of this insect appears to be that of inducing the flies to deposit their eggs in young wheat, and then destroying it. Where a third brood develops in volunteer wheat this end may be accomplished by turning under this volunteer growth when the Hessian-fly larvæ are about half-grown; or in case no such brood develops in the volunteer wheat, a few strips in the field may be seeded to wheat a few weeks before the regular planting time, and the flies will lay their eggs in these, which are afterwards to be plowed under. Thus the main crop of wheat will escape infestation.

The Chinch Bug

Blissus leucopterus

The chinch bug and the Rocky Mountain locust have long been known as the arch enemies of Western agriculture. They have each destroyed millions of dollars' worth of property, and have often caused great destitution over large areas. The chinch bug flourishes best at the South,



FIG. 150. CHINCH BUG. *a, b*, eggs; *c, e, f*, young; *g*, nymph or pupa; *h*, adult. Magnified.

but occasionally occurs in destructive numbers as far north as New York and Minnesota. Like other injurious insects it is subject to periodical uprisings, which usually continue one, two, or three seasons before the various natural checks upon its increase reduce its numbers below the danger line.

The adult chinch bug (Fig. 150, *h*) is a small blackish insect, slightly less than one-fifth of an inch long, with the legs dark yellow, and their tips black. The young (*c, e, f*) do not differ in general form from the adults. When first hatched they are pale yellow, but they soon become red; this continues to be the prevailing color until the pupal or last nymph stage (*g*) is

reached. The insect is then grayish or brownish-black. The eggs (*a*, *b*) are quite small, being about 0.03 inch in length, and amber colored. Short-winged varieties of the adult chinch bugs are sometimes found.

Professor S. A. Forbes has summarized the life history of this insect as follows: "The chinch bug passes the winter in the adult winged state (a few black wingless individuals occasionally occurring) under rubbish in or around the fields, in corn shocks and straw piles, under boards and among dead leaves in the woods, most abundant, usually, around the edges of the fields and in thickets, and around the borders of woods. From these lurking places such as survive the winter emerge in April and May (possibly sooner, if the season opens early), and, after pairing, lay their eggs in May and June, in fields of spring and winter wheat, barley, rye, oats and corn—chiefly in wheat and barley—most of the eggs being deposited in or near the ground, on the lower parts of the plants. Many of those hibernating around fields sown to wheat and barley make their way in on foot, thus attacking the outer edges first; but others take wing and scatter freely wherever suitable food invites them.

"By July most of the old bugs will be dead, and the new brood will be nearly full-grown,—far enough advanced by harvest to abandon the wheat fields for the nearest available food—oats or corn, if these are adjacent; otherwise and more rarely, grass. Making their way in on foot, only the borders of these fields will be at first attacked; but later, by the 1st of August at the farthest, the bugs not already located will begin to fly, and so will become generally disseminated through fields of corn. Here the eggs are laid behind sheaths of the lower leaves, and under the protection of this retreat the young hatch and mature, only coming out upon the exposed surfaces of the leaves when they become super-

abundant or when they get their growth. The full-grown bugs fly freely, singly but not in swarms, whenever their food fails them where they are. Rarely we find in the southern part of Illinois some trace of a third brood in a season, the young of these appearing in September in the corn—but these are in too small numbers to have any practical importance. The broods are mainly two, one breeding chiefly in wheat, and the other

almost wholly in corn, the adults of the latter brood passing the winter as above described. Each female is believed to be capable of laying about five hundred eggs.

“The chinch bug is practically confined for food to the great family of grasses (*Gramineæ*) which contains all the cereals and grasses, tame and wild. Some of these, however, it feeds upon with reluctance, if at all; and among the ordinary objects of its food it has its very decided preferences. Among the crop plants, wheat, barley



FIG. 151. CHINCH BUGS AFFECTED and rye, sorghum, broom
BY ENTOMOPHTHORA.

corn and Indian corn, millet and Hungarian grass are its favorite foods, with oats clearly second to these; while among the wild grasses its preference is for foxtail grass and ‘tickle grass’ (*Setaria* and *Eragrostis*).”

The chinch bug is subject to the attack of various predaceous insects and vertebrate enemies. Of the former the ladybugs furnish a good example, and of the latter certain birds, especially the quail, may be men-

tioned. But these enemies are insignificant so far as concerns their effects upon the numbers of the bugs, when compared with certain fungous or bacterial diseases to which these pests are liable. These diseases sweep them off by the million, and are usually the most potent factor in checking their outbreaks. One of these is a fungus that develops on the surface of the bug as a dense white covering. This disease is illustrated at Fig. 151: a number of the dead bugs are shown on a dead wheat stalk at the left, while a single bug, much magnified, covered with the fungus, is represented at the right. This fungus belongs to a genus of plants called by botanists *Entomophthora*.

Remedies.—Professor S. A. Forbes has divided the remedial and preventive measures applicable to the chinch bug into three general classes, namely: (1) Agricultural methods; (2) barriers against migration; (3) direct destruction. Under the first of these heads are included (1) clean farming, especially the cleaning up of refuse that may serve as protection for the bugs during winter, and the destruction of the grass-like weeds upon which they feed; (2) diversified farming and the culture of crops not affected by the chinch bug; (3) the temporary abandonment, in corn districts, of small grains, especially wheat and barley; and *vice versa*, the similar abandonment of corn in small grain districts; (4) heavy fertilization to enable the crops better to withstand attack; (5) the use of surplus seed, or the mixing of clover or timothy seed with small grains when sowed, to produce a heavy growth in which chinch bugs do not like to work; (6) plowing under the bugs and their eggs whenever this is practicable.

Under the head of barriers against migration are included: (1) plowing and harrowing at harvest time around infested fields, or plowing one or two deep furrows around the field; (2) pouring coal tar along the ground

just outside the infested fields and digging holes occasionally on the inside of the tar line for the bugs to fall into; (3) planting strips with crops not subject to injury by the chinch bug.

But the most satisfactory class of remedies consists of those by which the insects are killed outright, and in future outbreaks these will probably play a much more important part than in the past. The bugs are easily destroyed by kerosene emulsion, and by means of the improved spraying machines now upon the market this substance can advantageously be used against them. During fall, winter and spring, all infested grass lands, and so far as possible, wood lands, should be burned over to destroy the hibernating bugs. Remarkable success has also lately been attained in spreading, artificially, the fungous diseases of the chinch bug.

The Grain Aphis

Siphonophora avenæ

This insect occasionally becomes destructive to wheat and oats over large areas. It is a small greenish or



FIG. 152. WHEAT INFESTED BY GRAIN APHIS.

brownish aphid, with or without wings, which breeds upon wheat, oats, and various other plants of the grass family. It obtains its food by inserting a pointed beak into the leaf or stem and sucking out the sap. As the wheat gets ripe it migrates to the more succulent oats, and when these ripen goes to various grasses. It brings forth living young, and its rate of multiplication is very great, it being estimated that a single louse in spring

may become the ancestor of millions before autumn. The true sexed forms have not yet been found. The injury of these insects is chiefly manifested by the shriveling of the grain in infested fields.

Fortunately this insect has many natural enemies with which to contend. Chief among these are little four-winged parasitic flies, and various species of lady beetles. These natural enemies are undoubtedly the means of preventing this pest from overrunning grain-fields every year.

Remedies. — As yet no practical artificial remedy for the grain aphid is known. Kerosene emulsion will destroy them, but the difficulty of reaching them with it when they occur on the under surface of the leaf, makes the remedy hardly practical. We must ordinarily rely upon the weather and its various natural enemies to hold it in check.



FIG. 153. GRAIN APHIDES ON WHEAT HEAD. Magnified.

The Wheat-bulb Worm

Meromyza americana

This insect has attracted the attention of economic entomologists only during comparatively recent years. The adult is a handsome two-winged fly (Fig. 154, *d*), having two longitudinal yellowish stripes along its back. The females deposit eggs in the fall on the young wheat plants, and the larvæ, on hatching, feed upon the central

portion of the stem, just above the bulb of the plant. They remain here through the winter, becoming full-grown in spring. They are then footless cylindrical larvæ of the form shown at *b*. They pupate in the spring and

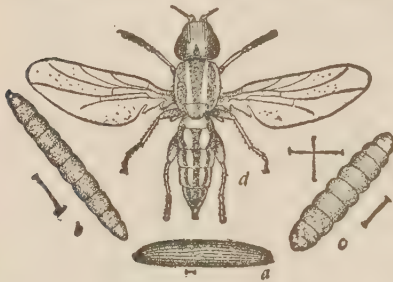


FIG. 154. WHEAT-BULB WORM. *a*, egg; *b*, larva; *c*, puparium; *d*, fly. Magnified.

a fortnight later emerge as flies. After mating, the female flies of this brood deposit eggs for larvæ which work into the straw, just above the last joint, thus cutting off the sap supply from the head and causing it to wither and dry up. These larvæ complete their transformations during July, when they are on the wing as flies. Early in July eggs are deposited by this brood of flies on volunteer wheat, and the transformations of these are completed in time for the adults to lay their eggs in the fall wheat. Consequently there are three broods each season. Besides wheat this insect breeds in oats and various grasses.

Remedies.—The destruction of volunteer wheat after the worms have got started in it, and the early planting of strips to induce them to oviposit, are the best remedial measures for this insect.

Wheat Jointworms

Isosoma hordei and *I. tritici*

There are two nearly related species of minute four-winged flies (Fig. 155) which deposit eggs in wheat stems that hatch into the so-called jointworms. According to Mr. F. M. Webster, "the females push their ovipositors into the stems of growing wheat and deposit

their eggs singly, but often several in each straw. This is done during the early spring, and again during June, in the latitude of Central Indiana, the young larvæ feeding upon the substance of the stem; but, being secure from ordinary observation, they are seldom noticed. We have found five of these larvæ at work on a single stem. These worms do not usually wither the straw,



FIG. 155. JOINTWORM. *a*, galls at joints; *b*, female fly. Magnified.

and the effect of their work is only to be observed in the shorter and more slender stem, shorter heads and smaller and less plump kernels.

“The larvæ are almost invariably found below the upper joint, and hence, by cutting the grain a little high, they can be left in the field, and as they pass the winter as pupæ in the same situation, by burning the stubble any time between harvest and the following March they can be destroyed. As the adults emerging from the old straws in spring are almost invariably wingless, they cannot travel about very rapidly. And hence changing the grain from one field to another, or rotating the crop, is often quite effectual in keeping them in check. Those adults appearing in June from the growing plants are provided with well-developed

wings, and can travel about from field to field with the utmost freedom."

INJURING THE HEADS

The Wheat Midge

Cecidomyia tritici

This insect is closely related to the Hessian fly. The adult is a small, two-winged, yellow or orange colored fly that appears in the wheat fields a few weeks before harvest time, and deposits its minute eggs in the crevices between the chaff of the wheat heads. These eggs soon hatch into little footless maggots that attack the young germ or kernel, blasting it. About three weeks later they become full-grown; they then leave the heads and enter the ground, where they pupate. There is but one brood each year. Besides wheat, the midge is said to breed in rye, barley, oats, and possibly grass.

Remedies.—Early-maturing grains are less liable to be infested by this insect than those ripening later. Consequently farmers in regions where it is present plant such varieties early, with general high culture. Many of the insects will be destroyed by the deep plowing of the infested fields.

INJURING STORED GRAIN

The Grain Weevil

Calandra granaria

There are several species of beetles infesting granaries, the habits and life histories of which, however, are quite similar. As an example we may take the imported grain weevil, the larva of which is represented at Fig. 156, *a*. The parent insect being a small, dark-red-dish snout beetle (*b*), deposits its eggs upon the grain. The eggs soon hatch into legless little larvæ that eat out

the substance of the kernels, and become full-grown (*a*) in a few weeks. They then change to pupæ and soon afterwards again transform to adult beetles. There are several broods each season. All sorts of stored grain, such as corn, oats, wheat, barley, etc., are attacked by these insects.

Remedies.—Bisulphide of carbon appears to be the best insecticide to use against grain weevils. The vapor of this substance is poisonous to insect life, and as it is heavier than air it will descend between the kernels of grain, destroying all the weevils which it reaches. Dr. C. V. Riley has lately called attention to the following method of using it, premising with the statement that one and a half pounds of bisulphide is sufficient for each ton of grain: “A ball of tow



FIG. 156. GRAIN WEEVIL. *a*, larva; *b*, beetle. Magnified.

is tied to a stick of such a length that it can reach the middle of the vessel containing the grain. The tow receives the charge of bisulphide like a sponge, and is at once plunged into the vessel and left there, the mouth or opening of the vessel then being tightly closed. When necessary, the stick may be withdrawn and the charge (of 1 ounce to 100 pounds of grain) may be renewed. The action of carbon bisulphide lasts in ordinary cases six weeks, after which period a fresh charge is required. The bisulphide does no harm to the grain as regards its color, smell, or cooking properties, and the germinating power of most seeds is not appreciably affected, provided that not too much is used, nor its action continued for too long a period.”

The Angoumis Grain Moth

Gelechia cerealella



FIG. 157. CORN INJURED BY GRAIN MOTH.

This insect derives its common name from the fact that it was first carefully studied in the province of Angoumois, France. It has long been known as a pest of extraordinary destructive power, and both in Europe and America has caused enormous losses. It is more injurious in the warm climate of the South than in the North. Mr. F. M. Webster has summarized its life history in these words: "The insect passes the winter in the larval state, pupates in the spring, and the moths appear in May or June. These pair immediately and deposit their eggs on the young grains of the new crop in the field, if they are allowed to escape, or, if not, on the grain in the bins where they originated. These eggs hatch in from four to seven days, and the larvæ burrow into the grain and themselves transform to moths, about August, or often during the latter part of July. These moths deposit their eggs after the manner of the previous brood, and the larvæ from these, nearly if not quite all, reach maturity during the fall and transform the following spring. The

number of broods and the time of appearances vary greatly with the climate and season ; in warm countries broods follow each other in rapid succession during the entire year." The easiest way of killing these pests is by means of the carbon bisulphide treatment described in connection with the grain weevil.

INSECTS AFFECTING CLOVER

INJURING THE ROOT

The Clover-root Borer

Hylastes trifolii

This insect was originally a native of Europe, from whence it was introduced into America not very many years ago. The adult is a

small, brownish-black, punctate beetle (Fig. 158, *d*), not quite one-tenth of an inch long.

It deposits eggs during spring in the crown of the clover plant, four or five eggs being laid on each plant. Shortly afterwards the larvæ hatch and burrow downward through the larger roots (*a, a*) feeding upon the inner substance, and filling the galleries behind them with their sawdust-like excrement. Late in summer the larvæ become fully grown (*b*), when they are one-eighth of an inch long, with a whitish body and yellow head. They

change to pupæ (*c*) within the tunneled roots (*a, a*), and shortly afterwards emerge as adult beetles. The species generally passes the winter in the beetle state, but occasion-



FIG. 158. CLOVER-ROOT BORER.
a, infested plant; *b*, larva; *c*, pupa; *d*, beetle; *b, c d*, magnified.

ly afterwards emerge as adult beetles. The species generally passes the winter in the beetle state, but occasion-

ally hibernates as a larva or pupa. The injuries of this insect are frequently very serious, whole fields of clover often being destroyed. Fortunately its ravages are as yet confined to a comparatively few States, but it is likely to spread over a large portion of the country.

Remedies.—In regions infested by this insect it has been found necessary to rotate the clover crop more frequently than before, mowing the seeded land but once, and pasturing or plowing under the abundant second growth. In this way the crop is turned under before the injuries of the borer become manifest. According to many of the most successful farmers, this frequent rotation is deemed desirable anyhow, so that the insect, in their opinion, is a means of compelling the adoption of an improvement in farm management.

INJURING THE LEAVES

The Clover-leaf Beetle

Phytonomus punctatus

Like so many other of our injurious insects, the native home of this species is Europe, from whence it was probably introduced into America many years ago, although it has only been seriously destructive here for a comparatively few years. It was first noticed in New York State, and as yet has not spread to very many other States, although it is likely to do so.

Dr. C. V. Riley, who first worked out the American life history of this species, has admirably illustrated this insect and its injury at Fig. 159. The adult (*i, j, k*) is a dark-brown snout beetle, not quite half an inch long, which feeds greedily upon the clover leaves at night, remaining concealed among the rubbish on the soil surface during the day. The female beetles deposit their eggs in irregular clusters in the hollow leaf or flower stems or between the leaf bracts at the base of the plant.

The eggs are very small, oval, smooth, and yellowish-green. Each female is capable of depositing 200 to 300 eggs. In about ten days the larvæ hatch and begin feeding on the leaves. They are legless little grubs of the form shown at *c*. They continue feeding and growing (*b, b, b*) for seven or eight weeks, increasing much



FIG. 159. CLOVER-LEAF BEETLE. *b, b, b, b*, larvæ feeding; *f*, cocoon; *i*, beetle—all natural size; *a*, egg; *c*, young larva; *g*, meshes of cocoon; *h*, pupa; *k, j*, beetle, back and side views—magnified.

in size and molting three times during the period. The larvæ, like the beetles, are mostly nocturnal in their habits, and ordinarily remain concealed during the day. The full-grown larvæ form pale-yellow cocoons, consisting of a coarse network of silk (*f, g*) in the soil, just beneath the surface. They pupate (*h*) within these

cocoons, and a month later emerge as beetles. There is apparently but one brood each season, although it is possible that there may sometimes be two. During the early summer months (May and June) it is mostly in its immature stages. It ordinarily hibernates as an adult, but may also occasionally pass the winter in the other stages of its existence.

Remedies.—The only remedy yet suggested is that of plowing under infested fields during May or June, thus destroying the immature stages.

INJURING THE HEAD

The Clover-seed Midge

Cecidomyia leguminicola

The clover-seed midge is a small orange-colored maggot that develops in the clover heads at the expense of the young seeds. It hatches from eggs laid by a very small, two-winged fly (Fig. 160, *a*), similar to the Hessian fly in appearance. The female is provided with a long ovipositor with which she pushes her eggs in among the young flowers. When the larva is full-grown (*b*) it wriggles its way out of

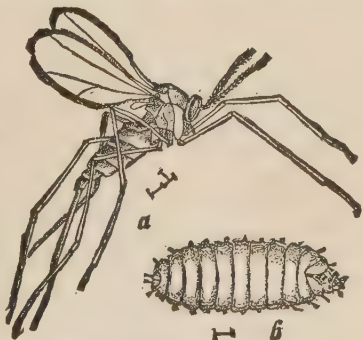


FIG. 160. CLOVER-SEED MIDGE. *a*, fly; *b*, larva. Magnified.

the head and falls to the ground, where at or just beneath the soil surface it forms a slight cocoon, within which it changes to the pupal state. About ten days later the flies emerge to lay eggs for another brood. In the Northern States there are two broods each season, while at the South there are at least three, and possibly

more. Clover fields infested by this insect are at once distinguished by the unnatural condition of the heads at time of blossoming; instead of being red with bloom, the heads are green and dwarfed on account of the undeveloped florets.

Remedies.—The best preventive of the injuries of this insect yet suggested is that of mowing the field about the middle of May (in the latitude of Central Ohio) when the green heads are just forming, and leaving the partial crop thus cut on the ground as a mulch and fertilizer. A new crop of blossoms is then produced, which comes between the regular crops, and also between the two broods of the midge. This method has been tried for several years by some of the best farmers of Ohio, with excellent results. The other remedies ordinarily recommended are early cutting of the first crop—about ten days earlier than usual—and pasturing the fields in spring. But there are serious objections to both these methods.

INJURING THE STEM

The Clover-stem Borer

Languria mozardi

This insect has been frequently discussed in entomological literature as an enemy to clover, but no record has yet been made showing that it ever seriously injures this crop. Until lately it was supposed to develop exclusively in clover, but recent observations indicate that it breeds more freely in other plants, especially certain weeds of the Composite family, than in clover. The adult insect is a small, elongate beetle, about one-fourth of an inch long, with the thorax yellowish-red, and the wing covers shining bluish-black. The larva is a slender, cylindrical creature, with three pairs of jointed legs on its under surface near the head, and a pair of pro-legs at

the posterior extremity. The pupa is usually of a yellowish color.

The eggs of this insect are evidently deposited in a great variety of plants, in the stems of which the larvæ develop, feeding upon the pith of the stalk. So long as there is a plentiful supply of wild plants, it is doubtful if it becomes of economic importance.

INJURING THE HAY

The Clover-hay Worm

Asopia costalis

Clover hay that has been standing in the mow or stack for some time is often infested by numerous small brown worms which web the dried stems and leaves together and feed upon them.

This is the insect named above, and its various stages are represented, natural size, at Fig. 161.

The adult is a very pretty little purple and golden moth (5, 6) which deposits its eggs upon such clover hay as it has access to. Sometimes the eggs are



FIG. 161. CLOVER-HAY WORM. 1, 2, larva, 3 cocoon; 4, pupa; 5, 6, moth.

deposited in the clover heads in the field. The eggs soon hatch into small brown worms that become full-grown (1, 2) in a few weeks. They then spin silken cocoons (3) within which they change to chrysalids (4), to emerge soon after as adult moths. There are two or more broods each season.

Remedies.—It will readily be seen that these insects are more likely to prove troublesome when old hay is left over from season to season for them to breed in. Consequently haymows should be thoroughly cleaned out each summer, and new stacks should not be put on old foundations until all of the leavings of the previous season are removed. Hay which is thickly infested by the worms should be burned.

INSECTS AFFECTING GRASS

INJURING THE ROOTS

The White Grub

Lachnosterna fusca

This notorious pest is the young or larva of the common May beetle or June bug. Its life history may be briefly summarized as follows: The brown beetles, shown at 3 and 4, Fig. 162, appear during May and June,

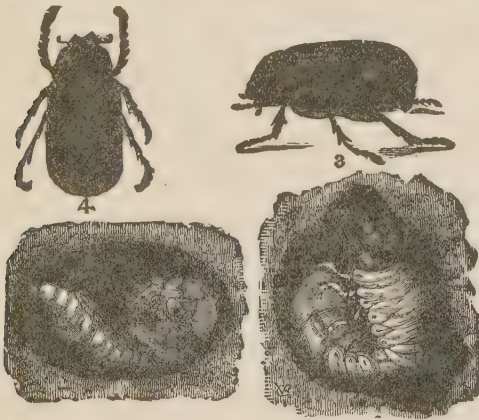


FIG. 162. MAY BEETLE. 1, pupa; 2, larva; 3 and 4, adult.

and feed at night upon the foliage of various fruit and shade trees. They deposit small whitish eggs among the roots of grass. These eggs hatch into small, brown-headed grubs, that feed upon the roots about them. They continue feeding for two seasons, when they are

full-grown and resemble 2, Fig. 162. They then form an oval cell in the soil and change to the pupal state, and soon after transform into beetles. The change to the pupal and beetle states generally occurs in fall, the beetles remaining in the ground until the following spring, so that they are often turned up during late fall or early spring plowing.

Remedies.—This insect is one of the most difficult pests to fight of its class. It breeds especially in grass lands, and often ruins pastures and meadows, while crops planted on sod land are very frequently destroyed. There is much evidence to prove that with high farming and short rotations its injuries may largely be prevented. The parent beetles may be destroyed by spraying the trees on which they feed with London purple or Paris green. It will often pay, when land infested by these grubs is to be planted to strawberries or other crops which they are liable to injure, to have boys follow the plow and collect the grubs as they appear in the furrow. In this way a large amount of damage can frequently be prevented at very slight expense. The grubs in infested meadows may be destroyed by turning swine in the field.

The Meadow Maggot

Tipula bicarnea

Meadows are sometimes injured by large, dark-colored, legless grubs of the form represented at Fig. 163, *a*, which feed upon the roots just beneath the surface. These are the larvæ of crane flies, the large two-winged insect represented natural size at *c* of the figure. The adults appear in spring, often in great numbers, and deposit numerous eggs in grass lands. In a short time these eggs hatch into small blackish grubs that feed upon the roots of grasses and other plants. They continue feeding for some time before becoming

full-grown,—their food including much decaying vegetation as well as the living roots,—when they are about an inch long, and of a dirty grayish-black color. They now change to pupæ, one of which is represented at *b*, and about a fortnight later the flies emerge with their long legs and slender wings. The larvæ are commonly called leather jackets or meadow maggots. In England the



FIG. 163. CRANE FLY. *a*, larva; *b*, pupa; *c*, adult.

crane flies are called daddy longlegs, although in this country this name is usually applied to the harvest spiders, a common species of which is represented at Plate XIV (p. 266). There are a great many species of these crane flies in America, and the later stages of one

of the largest of them are represented in the accompanying figure.

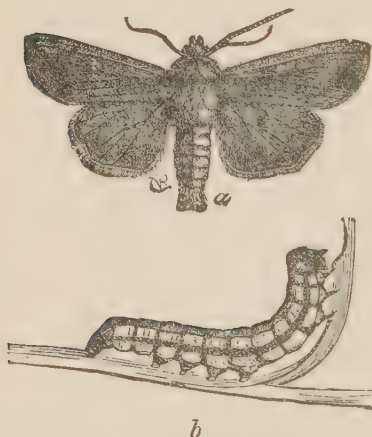
Remedies.—In America these insects rarely become sufficiently injurious to require remedial treatment. When they do, the most successful plan yet tried is that of driving a flock of sheep or herd of swine over the field to kill the larvæ by their trampling.

INJURING THE LEAVES

The Army Worm

Leucania unipuncta

This is one of the most noted insect enemies of American agriculture. It occasionally does great damage



to a variety of cereal and forage crops, although during recent years its irruptions appear to be growing less frequent. The worm itself is closely related to the cutworms, to which it is similar in life history and habits. It hatches from eggs laid by a handsome brown moth (Fig. 164, *a*), between the sheaths of grass blades. The

FIG. 164. ARMY WORM. *a*, moth; *b*, larva. young larvæ hatch in a week or ten days, and are at first green, but later become ornamented with longitudinal stripes of yellow, gray, and black (*b*). The larva feeds upon the leaves of grass, wheat, oats, rye, etc., and becomes full-grown in about a month from the time of hatching. Ordinarily it remains concealed about the bases of grass or grain, feed-

ing there unnoticed, but occasionally the larvæ become so numerous that they exhaust their food supplies, and then they are forced to seek other feeding grounds. At such times the "armies" appear, and moving in solid masses sweep all grasses and cereals before them. The full-grown larvæ enter the ground and pupate in earthen cells, emerging a fortnight later as moths. In southern latitudes there are two or three broods each season, while at the North there are one or two. The insect hibernates both as a moth and larva, although the latter doubtless predominates.

The army worm has a great many enemies with which to contend. It is preyed upon by birds, as well as by predaceous and parasitic insects, and is subject to the attacks of certain bacterial diseases that often sweep the larvæ off by millions. These various natural enemies are the chief means of keeping the pest in check.

Remedies.—The burning of pastures and meadows during fall, winter, or spring, especially the latter, is very often recommended as a remedy for the army worm, and large numbers of the larvæ may thus be destroyed. The migration of the worms from field to field may be prevented by plowing deep furrows with the perpendicular sides away from the worms, or by setting fence boards on edge, leaning a little toward the worms, and smearing the upper edge with coal tar. With the improved appliances for distributing Paris green and London purple now in use, these poisons will no doubt be more largely used in suppressing future outbreaks of these worms than in the past. It is quite probable also that we may before long be able to fight them by means of the germs of the contagious diseases to which they are subject.

Grasshoppers

Acrididæ

The family of locusts or short-horned grasshoppers—commonly called simply grasshoppers—contains many species which are more or less injurious in pastures and meadows. The hind legs of these insects are long and strong, enabling them to make the leaps or hops which has given them their common name. The largest species of this family inhabiting the United States is the bird grasshopper or American locust (*Acridium americanum*), represented natural size at Fig. 165. At a little distance, when flying, this handsome insect might easily be mis-



FIG. 165. BIRD GRASSHOPPER OR AMERICAN LOCUST.

taken for a small bird. It inhabits the Southern States, but occurs rather commonly as far north as the fortieth degree of latitude.

The Rocky Mountain locust or Western grasshopper (*Melanoplus spretus*) is the most destructive American insect of this family. Its stages of growth are shown at Fig. 166. The eggs are laid during the late summer or early autumn months, in masses of twenty or thirty each, in the soil just below the surface. They remain over winter in this condition, hatching in spring into wingless little hoppers as shown at *a, a*. They gradually increase in size, and cast their skins after a short time, when they

resemble *b*. They acquire wing pads in the stage immediately preceding that of the adult, as shown at *c*, and finally become full-fledged (*d*). They are active during their entire existence. The native home of this species is in the high and dry table-lands of the Rocky Mountain regions, where it breeds year after year. Occasionally it becomes so abundant in these regions that the food supply is exhausted, and it is compelled to seek by flight green pastures. It is at such times that these insects migrate in vast swarms to the fertile fields of the Mississippi valley, destroying every vestige of greenness in their path. Fortunately, however, they are unable to breed permanently at these lower levels, and although eggs are deposited by these invading hordes, the young hoppers hatched from them seldom attain a healthy development.



The commonest grasshopper in the Northern States is called the red-legged locust (*Melanoplus femur-rubrum*). It is closely allied and very similar to the Rocky Mountain locust. It frequently becomes seriously destructive in restricted localities, but never does the widespread damage of its Western congener. The life history of this species has been summarized by Professor S. A. Forbes as follows: "These locusts are single-brooded; they hibernate in the egg, hatching in midsummer; pass through five successive molts, gaining their full size, and with this their wings, in August, and commence to lay eggs in September. The females deposit these in the earth, boring cylindrical holes for the purpose with the abdomen, and laying the

FIG. 166. ROCKY MOUNTAIN LOCUST.
a, *b*, young nymphs; *c*, fully developed nymph or pupa; *d*, adult.

eggs in a symmetrical mass within the burrow thus formed. With the egg mass is extruded a quantity of mucus, which soon hardens and forms a sort of case or matrix, in which the eggs are imbedded. The upper part of the hole is also filled with this mucus. The female is commonly busied from two to four or five hours in the deposit of a single egg mass, and lays, ordinarily, from two to four such masses in different holes, upon different days, commencing the process of oviposition, as a rule, about a month after she has acquired her wings. After this process is completed the exhausted females soon perish. They select by preference, for oviposition, hard and dry ground, roadsides and pastures being especially favorite localities. Meadows and pastures are commonly resorted to by the mature females, especially the latter, as the eggs seem not to be laid ordinarily on ground covered by luxuriant vegetation. I have never known them deposited in cultivated earth.

“The food habits of these locusts are extremely simple, and consist in eating nearly everything that comes in their way. They are quiet at night, and indeed, as they mature, they select elevated positions as roosts, climbing to the tops of stems of grass in meadows, to the tassels of the stalks in cornfields, and even deserting fields of low herbage if they can find more elevated roosting points near by. When very abundant, and when the weather continues dry, they occasionally swarm like the Rocky Mountain locust, but rarely flying continuously to any great distance, or indeed taking any definite course.”

Fortunately there are a considerable number of species of animals that depend, to a greater or less extent, upon grasshoppers for subsistence. Some of these are predaceous, others parasitic, but all combine in keeping the pests in check. Prominent among those efficient in this work are the species that live upon or within the

eggs of the locusts, as the latter exist in that state for the longest period of their lives, and are also then the most helpless and susceptible to injury. The common blister beetles (*Epicauta*) live, so far as known, in their larval state, exclusively upon the eggs of locusts, and are thus of immense benefit to man. Small red mites, which are frequently seen attached to the bodies of the mature locusts, are also of benefit, in that while young they suck the life juices of the locusts, and later, puncture their eggs and extract the contents. The larvæ of the common black ground beetles (*Carabidæ*), which are to a great extent carnivorous, also feed upon the eggs, and, as they are everywhere abundant, contribute not a little to lessening their numbers. Certain species of two-winged flies (*Diptera*) are also known to be parasitic upon the eggs as well as upon the adults.

Remedies.—The time when grasshoppers can most successfully be fought is when they are either in the egg or young larval states. Shallow plowing and harrowing during autumn of fields where they are deposited, will break up many of the egg pods, exposing them to enemies and the weather. The methods by which young locusts may be destroyed have been classified by the United States Entomological Commission as follows: (1) burning, (2) crushing, (3) trapping, (4) catching, (5) use of destructive agents. By the first method old hay or straw is scattered “over and around the field in heaps and windrows, into which the locusts for some time after they hatch may be driven and burned.” When the weather is cold and damp the locusts will seek the shelter of the hay or straw, and may easily be burned before escaping. This method is well adapted to upland pastures, where the eggs are usually deposited in the greatest numbers.

For the successful application of the second method mentioned above, it is necessary that the surface of the

fields on which it is applied should be smooth and hard. Here, again, the upland pastures present unusually favorable opportunities for successful work. Dr. Riley states: "Where the surface of the ground presents this character, heavy rolling can be successfully employed, especially in the mornings and evenings of the first eight or ten days after the newly hatched young have made their appearance, as they are generally sluggish during these times, and huddle together until after sunrise."

The third head given above, that of trapping, includes ditching, trenching, and the use of pans covered with coal oil, or coal tar. In the first two processes, ditches or trenches are dug in favorable situations, into which the young insects are driven. Probably the use of pans covered with coal oil will be as simple and advisable a method, unless we except that of rolling, as can be employed in most infested districts. A small pan which is well adapted for the purpose is described as follows: "A good and cheap pan is made of ordinary sheet iron eight feet long, eleven inches wide at the bottom, and turned up a foot high at the back and an inch high at the front. A runner at each end, extending some distance behind, and a cord extending to each front corner, completes the pan, at a cost of about \$1.50." The upper surface of the bottom is wet with kerosene, and the pans are pulled rapidly through the field by boys who take hold of the ropes.

The use of destructive agents, such as London purple, Paris green, and the like, has not been attended with any very great success when applied on a large scale. But for limited areas, doubtless a great many of the locusts may thus be easily destroyed. A mixture which has been successfully employed consists of "arsenic, sugar, bran, and water, the proportions being one part, by weight, of arsenic, one of sugar, and five of bran, to which is added a certain quantity of water. The arsenic

and bran are first mixed together, then the sugar is dissolved in water and added to the bran and arsenic, after which a sufficient quantity of water is added to thoroughly wet the mixture. About a teaspoonful of this mixture is thrown upon the ground at the base of each tree or vine (in gardens or orchards) and left to do its work. The poison works slowly, seldom killing its victim within eight or ten hours after it has been eaten."

PART VI

INSECT PESTS OF DOMESTIC ANIMALS AND THE HOUSEHOLD

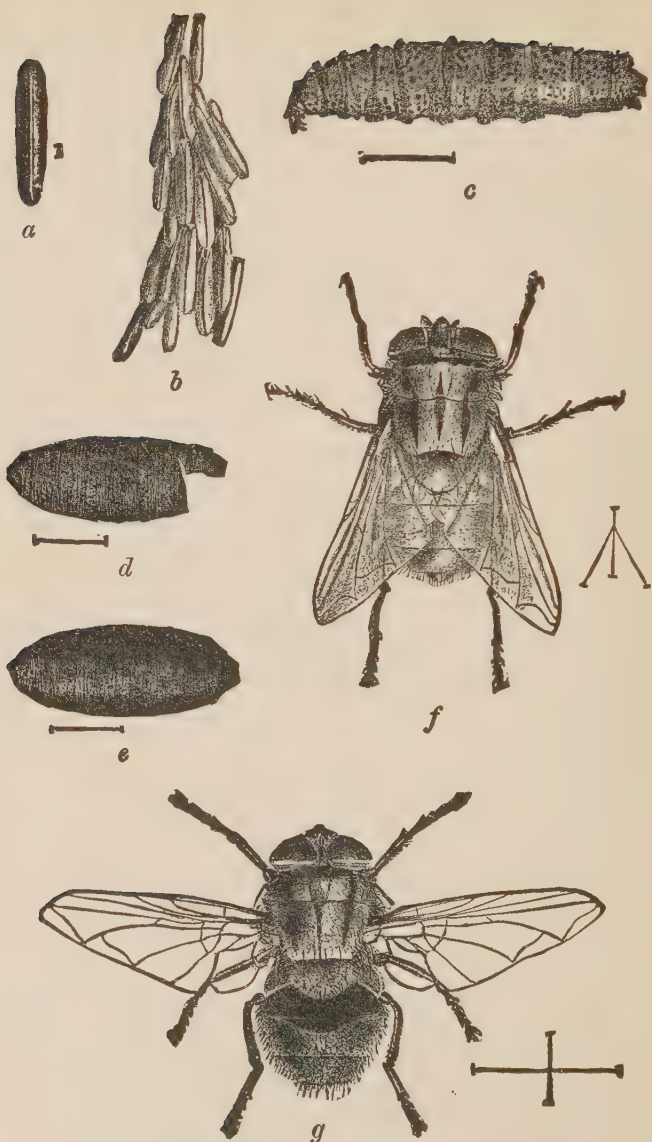


PLATE XVI.—THE SCREW WORM.

INSECTS AFFECTING DOMESTIC ANIMALS

The Screw Worm

Compsomyia macellaria

The screw worm, so far as its injuries are concerned, is a Southern insect. Until recently little or no damage from it had been reported outside of Texas, but lately it has been injurious in Louisiana, Mississippi, and other Southern States. The fly, however, occurs throughout America "from Canada to Patagonia," probably breeding in northern latitudes in decaying animal and vegetable matter. Although in the South cattle are especially liable to the attacks of this insect, it is by no means confined to them, for horses, mules, hogs, sheep, dogs, and in some recorded cases even men, suffer on account of it.

"In all animals alike," according to Dr. M. Francis, who has studied this insect carefully, "the eggs, after being laid by the fly, hatch into larvæ, or so-called 'worms.' The exact length of time this requires seems to vary with circumstances. My present opinion is that if the eggs are laid in a moist place and on a warm day, it requires less than one hour; whereas if laid in a dry place, they seem to dry up and lose their vitality. The young larvæ, when first hatched, are small and easily overlooked. If they are hatched on the surface in a drop of blood from a ruptured tick, for instance, they attempt to perforate the skin, and if hatched in wounds they at once become buried out of sight. They seem to attach

themselves by their heads, and burrow their way under the skin, completely devouring the soft flesh. Occasionally a few are seen moving from one place to another, but usually they remain fixed at one point. The worms grow steadily in size, and the hole in the flesh becomes larger every day. Sometimes the worm makes tunnels, but not to any depth; they usually stay on the surface. They evidently produce considerable irritation, for the part is always swollen and constantly bleeding. This swollen, gaping appearance of the wounds, together with the constant discharge of blood, are characteristic of the presence of worms. It seems to require about a week for the worms to become fully grown. At that time they are about five-eighths to six-eighths of an inch long. They then leave the sore and go into the ground, where they pass the pupal state, and hatch out as flies in from nine to twelve days."

In the accompanying plate (XVI) the eggs are shown at *a* and *b*, the first representing a single egg, greatly enlarged, and the second a bunch of eggs, also enlarged; the larva is represented at *c*, and the puparium at *d* and *e*, the former showing the mode of exit of the fly, which is represented at *f* and *g*.

The egg of this insect is one-twenty-fifth inch long, whitish, and cylindrical, with a longitudinal ridge on one side. The full-grown larva is one-fifth inch long by one-sixth inch in diameter. It is a whitish, footless grub, with transverse rows of stiff, black bristles at each articulation. The puparium is brown, and two-fifths inch long. The imago is described as follows: Length two-fifths inch; wing expanse, four-fifths inch; color, metallic bluish-green, with golden reflections; thorax with three black, longitudinal stripes; head, except central portion of eyes, yellow; legs, black; wing veins black; wings, transparent, except near base, where they are slightly clouded; entire body furnished with long

black, spinose hairs; proboscis of medium length, with dilated tip.

Remedies.—According to Dr. Francis, the treatment usually employed consists simply of killing the larvæ with cresylic ointment, calomel, chloroform, or carbolic acid. Inasmuch as the insect is able to develop freely in decaying animal and vegetable matter, it is important, as a preventive measure, that all refuse be promptly buried or burned.

The Ox-warble or Heel Fly

Hypoderma lineata

During the spring and early summer one may often find along the middle of the backs of cattle, just beneath the skin, a hard lump, usually having in the center an

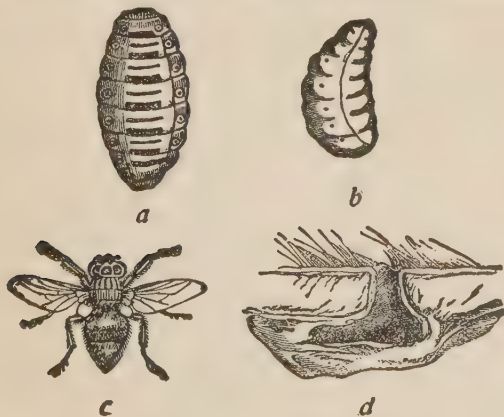


FIG. 167. AN OX WARBLE. *a*, larva; *b*, pupa; *c*, fly; *d*, section of warble.

opening, which sometimes is more or less of a running sore. These are the “warbles,” and the lump is caused by the presence of a whitish or grayish maggot of the form represented at *a*, Fig. 167, which represents a species closely related to the one here considered. The life

history of this insect is remarkable. The eggs are laid in spring by the flies on the hairs of cattle, especially on the hinder portion of the body and about the heels. "The cattle licking themselves remove the eggs and hairs, for this is the shedding season. The eggs hatch by virtue of the warmth of the mouth, and the newly hatched larva, provided with a number of spinous points and anal hooks, penetrates through the walls of the œsophagus. It then molts, looses the spines, and becomes



FIG. 168. AMERICAN OX-WARBLE FLY.
Magnified.

almost entirely smooth with the exception of some very minute spines around the anal portion. Its skin is underlaid with strong muscular bands, fitting it for pushing its way through the tissues. In this stage its development is very slow, and it gradually works its way through the subcutaneous tissue, traveling for nine or ten months, until it has reached a favorable point upon the back, where it molts again, assuming the familiar, spiny appearance of the mature larva, becomes encysted by virtue of the inflammation of the tissue, and from this inflammation and from its own growth forms a decided lump under the skin. After another molt the skin of the animal is penetrated, and eventually the larva issues through this hole and falls to the ground to transform to the pupa."* In about a month it emerges as an adult fly (Fig. 168). The ulceration caused by these larvæ is not only dis-

trussing to the animal, but injures the hide and beef, and, in the case of dairy animals, lessens the quantity of milk produced.

The beef beneath these warbles has a peculiar, diseased, sickening appearance, and is commonly called "licked beef." Such beef always commands a lower price than that which is unaffected.

Remedies.—Every warble maggot destroyed before it escapes to the ground to pupate, means that one less fly will be present to lay eggs for the coming brood. This should be carefully borne in mind, for from it the conclusion is obvious that if all the maggots present in the backs of cattle of a given neighborhood are killed, the egg-laying brood of flies will be exterminated, and there will be no injury the next season. There is perhaps no other important injurious insect whose numbers can be so readily controlled; and the experience of English farmers shows that by concerted action and the continuation of the treatment, the amount of warble attack may be very rapidly lessened.

Perhaps the simplest remedy is to squeeze the maggots out of the warbles. When they are nearly full-grown this can be done with little trouble. A pair of medium sized forceps is often helpful in removing them.

Another simple remedy is to apply to the opening a little oil or grease, which closes the breathing pores of the maggot, thus causing it to die. Kerosene applied to the warbles either in autumn, winter or spring also destroys them, as does indeed the application of almost any oily or fatty substance. Train oil or fish oil is especially commended in England. Dr. C. V. Riley says that smearing the animals' backs with this substance "is the simplest and easiest method of destroying the warbles, which it does by closing the breathing pores on the posterior end of the body. The destruction of the larvæ in this way may be effected by one or two applications in

autumn, and is the most satisfactory method of controlling the pest."

Cattle Lice

There are three species of lice infesting cattle. Two of these belong to the group of sucking lice and the third is one of the biting lice. They are called (1) the short-nosed ox louse, (2) the long-nosed ox louse, and (3) the biting ox louse.

The short-nosed ox louse (*Hæmatopinus euryster-nus*) is represented considerably magnified at Fig. 169, *a*. Full-grown females of this species are one-sixth of an inch long, and the males are somewhat smaller. The

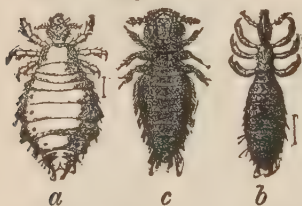


FIG. 169. LICE. *a*, *b*, sucking ox lice; *c*, biting horse louse. Magnified.

beak or rostrum is provided with little hooks by which it may be firmly attached to the skin, and within these hooks there is a slender sucking tube having a piercing extremity which the insect pushes through the skin of its host, and sucks the blood. The

eggs are glued to the hairs of the cattle, and the young lice do not differ essentially in appearance from the adults, except, of course, in size. These insects generally infest the neck and shoulders of cattle.

The long-nosed ox louse (*Hæmatopinus vituli*) is represented magnified at Fig. 169, *b*. As will be seen, it differs materially in appearance from the other species, being at once distinguished by its longer and more slender body. It is about one-eighth of an inch long, and obtains its food by suction.

An idea of the form of the biting ox louse (*Trichodectes scalaris*) may be obtained from Fig. 169, *c*, which represents a closely related insect infesting horses. This species differs also in color from the sucking cattle lice, being of a reddish hue. Its eggs are glued to the hairs

of the cattle. It is very abundant in all parts of the world where domestic cattle are found.

Remedies.—The best method of destroying lice on cattle and other domestic animals is to apply a thoroughly prepared emulsion of kerosene and soap, made as directed in the Introduction (page 43). If this is well made it can be applied to cattle and horses, hogs and sheep, with no danger of injury to them, while it will destroy all the lice with which it comes in contact. Professor C. P. Gillette, who first gave this method a thorough trial, recommends applying it with a force pump and spray nozzle, rubbing it in thoroughly with the finger tips at the same time. It kills the lice and leaves the hair of the animal in good condition. The lice may also be destroyed by treating with a strong tobacco decoction—a pound of tobacco being boiled in two gallons of water—or a wash of carbolic-acid soap. But the first-named remedy is best.

The Horn Fly

Hæmatobia serrata

This is an imported insect which has lately attracted much attention in the Eastern States. It is called the



FIG. 170. *a*, horn fly, magnified; *b*, cow horn with band of resting flies, reduced.

horn fly because of the peculiar habit the flies have of gathering in clusters upon the base of the horn, as repre-

sented in Fig. 170, *b*. They light here to avoid being disturbed by the heads or tails of the cattle, but do not pierce the horn or do any serious injury to it. On the body, however, where they light when feeding, they insert their beaks into the skin, injecting at the same time a little poisonous secretion which causes irritation and inflammation, and a flow of blood to the spot. This blood is then sucked into the stomach of the fly. Cows thus attacked become restless and irritable, and, if the flies are very numerous, they lose flesh and give less milk.

The eggs of the horn fly are deposited in freshly dropped cow dung in which the larvæ develop, and pupate in the soil beneath. There are four or five broods each season. During hot weather the transformations of the insect—from egg to imago—may be completed within two weeks.

Remedies.—Two classes of preventives may be used against this insect. The injuries to cattle may be prevented by applying to their bodies, by means of a sponge, fish oil to which has been added a little carbolic acid. Only the tips of the hairs need be wet, and the application should be repeated every four or five days. This will keep the flies off the animals though it does not kill them. They may be killed, however, by the use of tobacco powder, dusted on the cattle, especially on the back, tail, neck, and base of the horns. Professor J. B. Smith recommends the use of the carbolated fish oil on the belly, udder, and other parts of the body where the tobacco cannot well be applied, and the application of the powder to the other parts. The larvæ also may be destroyed by spreading out the cow droppings each morning, so that they will dry up, and thus prevent the development of the eggs or maggots, or by mixing plaster with the manure in the stable or field.

Lice Infesting Horses

Three species of lice infest the horse. The first is the sucking horse louse (*Hæmatopinus asini*) which is represented, considerably magnified, at Fig. 171, *a*. It is somewhat similar to the sucking ox louse, to which it is closely related, but is easily distinguished from that species by the shape of the head. It is the rarest of the three species infesting the horse, the next commonest one being the rarer biting horse louse (*Trichodectes pilosus*) represented at Fig. 171, *b*, which, as its name

indicates, is less abundant than the third species—the common biting horse louse (*Trichodectes parumpilosus*), which is shown at Fig. 169, *c*. This last is the most abundant and annoying, and is especially liable to infest colts or horses that have been in pasture for some time. It occurs mostly about the



FIG. 171. *a*, sucking horse louse; *b*, biting horse louse. Magnified.

head, mane, and tail; and is generally thickest in spring. The front part of the body is brownish, and the abdomen is yellowish white, with eight transverse dark bands upon the back.

Remedies.—The remarks concerning remedies for cattle lice are equally applicable to these species.

INSECT PESTS OF THE HOUSEHOLD

Cockroaches

Cockroaches are among the most omnivorous as well as omnipresent of the insect pests of the household. Their flattened bodies especially fit them to dwell in cracks and crevices, in the walls of houses in cities, and beneath the loose bark of fallen trees in the woods. Here they find congenial retreats and flourish abundantly. They take a great variety of food. In dwellings they destroy provisions of every kind, although, as a partial recompense, perhaps, they are also said to prey upon bedbugs.

As has been so often the case with our injurious insects, we are indebted to Europe for the cockroaches that are most obnoxious. The American cockroach (*Periplaneta americana*) occurs commonly in the fields and woods, and occasionally is found in houses. But the oriental cockroach (*Periplaneta orientalis*) and the Croton bug or German cockroach (*Phyllodromia germanica*)—both imported species—prefer the city dwelling, where, around the steam and water pipes of the kitchen, laundry or bathroom, they can run about undisturbed. They are nocturnal in their habits, remaining concealed during the day, and sallying forth in search of food during the night.

The life history of the Croton bug has been admirably portrayed by Dr. C. V. Riley at Fig. 172. The eggs are laid in a pod or egg case (*f, g*) from which the young roaches hatch. They pass through various molts as

represented at *a*, *b*, *c*, *d*, and do not acquire wings until full-grown (*e*, *f*, *h*), when they are nearly two-thirds of an inch long. The other roaches develop in a similar way.

Remedies.—The best remedy for these pests is a good quality of insect powder, such as buhach. In recommending this, Dr. Riley says: "Just before night-fall go into the infested rooms and puff it into all crevices,



FIG. 172. CROTON BUG. *a*, first stage; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, adult; *f*, adult female with egg case; *g*, egg case—enlarged; *h*, adult with wings spread—all natural size except *g*.

under baseboards, into drawers and cracks of old furniture—in fact wherever there is a crack—and in the morning the floor will be covered with dead and dying or demoralized and paralyzed roaches, which may easily be swept up or otherwise collected and burned. With cleanliness and persistency in these methods the pest may be substantially driven out of a house, and should never be allowed to get full possession by immigrants from without."

The Buffalo Carpet Beetle

Anthrenus scrophulariæ

The buffalo carpet beetle is supposed to have been introduced into America from Europe about 1876, since when it has done great damage and spread over a large portion of the Eastern and Central United States. The adult beetle (Fig. 173, *d*) is about a quarter of an inch long, black, with white spots, as shown in the figure, and has a red stripe along the middle of the back. Eggs are laid by these beetles, probably upon carpets themselves,

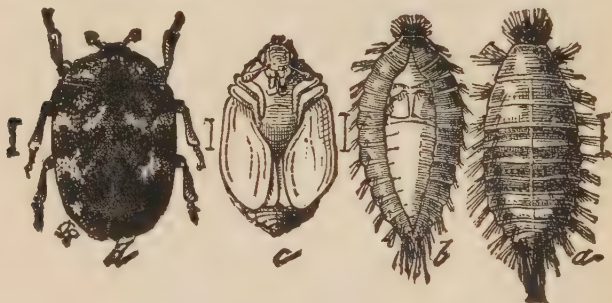


FIG. 173. CARPET BEETLE. *a*, larva, back view; *b*, larva, view of under side; *c*, pupa; *d*, beetle. Magnified.

and soon hatch into larvæ that feed upon the carpets. It is in this larval stage that the damage is done. The larvæ cast their skins occasionally as they develop, and the time required for them to become full-grown varies according to the temperature and food supply. When full-grown they are peculiar, hairy creatures of the form represented at *a* and *b* of the accompanying figure. They now hide in a crack or crevice, and change to pupæ (*c*) inside the hairy skin. In a short time they again change to the beetle state, the beetles emerging throughout the fall, winter, and spring. There is probably, in ordinary cases, but one generation a year, at least in the Northern States.

Remedies.—In Europe this insect does very little damage, because rugs are used instead of carpets. Rugs are taken up and shaken so often that the insects have no opportunity to multiply. The use of rugs should therefore be encouraged in regions where the insect is troublesome.

Perhaps the most practical way of really destroying these insects in carpets without taking them up, is to lay two or three thicknesses of wet cloths on the carpet, and iron with hot flatirons. Steam will thus be generated, which will permeate the carpet and kill the insects. The pests may readily be killed in furniture or garments by the use of benzine or gasoline, applied as a spray by some sort of atomizer, *always remembering that these substances must not come in contact with fire in any shape.* “At housecleaning time,” says Dr. Riley, “as many of the rooms should be bared at once as possible, and the housekeeper should go carefully over the rooms, removing all dust, and with a hand atomizer charged with benzine should puff the liquid into all the floor cracks and under the baseboards until every crevice has been reached. The carpets themselves, after thorough beating, should be slightly sprayed with the same substance, which will quickly evaporate, leaving no odor after a short time. The inflammability of benzine, however, should be remembered, and no light should be brought near it.”

The Bedbug

Acanthia lectularia

A short account of this notorious pest will be sufficient for the present purpose. Many people will recognize the peculiar flattened creatures represented at Fig. 174, as former acquaintances, and those who do not so recognize them are to be congratulated. The eggs of

these insects are laid in the cracks of walls and bedsteads, and the young (*a*) do not differ essentially, except in size, from the adult (*b*). Bedbugs are able to exist a



FIG. 174. BEDBUG. *a*, young; *b*, adult. Magnified.

long time without food, and on the other hand, when food is abundant they multiply with remarkable rapidity.

Remedies.—Spraying the cracks of walls, beds, etc., where these insects occur with benzine is the best manner of destroying them. This substance kills the eggs as well as the adults. Great care, of course, should be taken to prevent their ingress to the house.

Clothes Moths

There are three closely related insects in the United States which may properly be called clothes moths. They are quite similar in appearance, but the larvæ differ somewhat in feeding habits. The commonest one probably is the case-making clothes moth (*Tinea pellionella*), the life history of which Dr. Riley has thus summarized: "The small light-brown moths, distinguished by the darker spots at intervals on the wings, begin to appear in May and are occasionally seen flitting about as late as August. They pair and the female then searches for suitable places for the deposition of her eggs, working her way into dark corners and deep into the folds of garments, apparently choosing by instinct the least conspicuous places. From these hatch the white, soft-bodied larvæ, each one of which begins immediately to make a case for itself from the fragments of the cloth upon which it feeds. The case is in the shape of a hollow roll or cylinder and the interior is lined with silk. As

they grow they enlarge these cases by adding material to either end and by inserting gores down the sides which they split open for the purpose. The larva reaches its full growth toward winter, and then crawling into some yet more protected spot, remains there torpid through the winter within its case, which is at this time thickened and fastened at either end with silk. The transformation to pupa takes place within the case the following spring, and the moths soon afterward issue. The larva feeds in all woolen cloths, and also in haircloth, furs and feathers."



FIG. 175. CLOTHES MOTH. *a*, moth; *b*, larva; *c*, web. Magnified.

Remedies.—Under

this head we cannot do better than to quote the following remarks by Dr. Riley, who lately published an admirable series of articles, first in *Good Housekeeping* and afterwards in *Insect Life*, to which we are largely indebted for the information and illustrations on this subject. He says: "During the latter part of May or early in June a vigorous campaign should be entered upon. All carpets, clothes, cloth-covered furniture, furs and rugs should be thoroughly shaken and aired, and, if possible, exposed to the sunlight as long as practicable. If the house is badly infested, or if any particular article is supposed to be badly infested, a free use of benzine will be advisable. All floor cracks and dark closets should be sprayed with this substance. Too much pains cannot be taken to destroy every moth and every egg and every newly hatched larva, for immunity for the rest of the year depends largely—almost entirely—upon the thoroughness with which the work of extermination is carried on at this time. The benzine spray will kill the insect in every stage, and it

is one of the few substances which will destroy the egg. I would however repeat the caution as to its inflammability. No light should be brought into a room in which it has been used until after a thorough airing and until the odor is almost dissipated.

“The proper packing away of furs and winter clothing through the summer is a serious matter. A great deal of unnecessary expenditure in the way of cedar chests and cedar wardrobes and various compounds in the way of powders has been urged by writers on these pests. But experience fully proves that after a thorough treatment in May or June, garments may be safely put away for the rest of the season with no other protection than wrapping them closely in stout paper, to preclude infection through some belated female. My assistant, Mr. L. O. Howard, tells me of an excellent plan which he has adopted. He buys for a small sum from his tailor a number of pasteboard boxes in which they deliver suits, and his wife carefully folds and packs away all clothing, gumming a strip of wrapping paper around the edges of the cover so as to leave no crack. These boxes will last for a lifetime with careful use. Others use for the same purpose ordinary paper flour sacks or linen pillowcases, which answer well. The success of these means depends entirely on the thoroughness of the preliminary work. Camphor, tobacco, naphthaline, and other strong odorants are only partial repellants, and without the precaution urged are of little avail.

“Cloth-covered furniture which is in constant use will not be harmed, and the same may be said of cloth-lined carriages. Where such furniture is stored away or kept unused in a dark room, or where the carriages are left in a dark coach house through the summer, at least two sprayings with benzine, say once in June and once about August first, will be advisable. Another plan which will act as a protection in such cases is to

sponge the cloth linings and covers both sides where possible, with a dilute solution of corrosive sublimate in alcohol, made just strong enough not to leave a white mark on a black feather."

Ants

Ants frequently become one of the most annoying kinds of household pests by getting into and running over everything. The species most generally troublesome is the little red ant (*Monomorium pharaonis*), which is worldwide in its distribution—although it is said to have been originally a native of Europe. The worker of this ubiquitous pest is represented at Fig. 176, *a*; and the female at *b*, of the same figure. The nests are made in almost any concealed position about the house—under floors, behind baseboards, between walls, or in the walks or grass about the house. From these nests the foraging parties sally forth and overrun the house, devouring or carrying off particles of food of all descriptions, getting into everything in sight, and often becoming an intolerable nuisance.

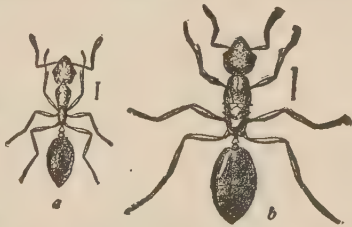


FIG. 176. LITTLE RED ANT. *a*, worker; *b*, female. Magnified.

Remedies.—The first essential to a successful fight with these insects is to find the location of the nests. If they can then be reached it is easy to destroy them by means of benzine, gasoline, bisulphide of carbon, or even hot water—anything in fact, that will kill them. If any inflammable or explosive substances are used, of course great care must be taken to keep away fire in any form.

There are certain larger ants that are frequently troublesome on lawns, by making their nests above the

surface of the grass, and thus disfiguring them. A **simple** way of destroying these is recorded by Dr. Riley, as follows: A number of holes are punched in the nest by means of a pointed stick; a teaspoonful of bisulphide of carbon is then poured down each hole, and a damp blanket is thrown over the nest for a few minutes—then the blanket being removed, the bisulphide is exploded at the mouth of each hole by means of a light at the end of a pole. The slight explosions drive the poisonous fumes down through the underground tunnels, killing off the ants in enormous numbers.

The little red ants may be trapped by means of small sponges, saturated with sweetened water, and then occasionally dropped into boiling water. But this is a much less satisfactory method than that of destroying them in their nests.

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